ELECTRICAL REVIEW

THE PIONEER ELECTRICAL WEEKLY OF AMERICA

VOL. XLVII. No. 12. NEW YORK, SATURDAY, SEPTEMBER 16, 1905. ISSUED WEEKLY

CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. . . . L. W. MARSHALL, Manager
BOSTON OFFICE: 161 Devonshire Street . . . . . M. W. BARBER, Manager
EUROPEAN OFFICE: 42 Old Broad Street, London, E. C. . . HENRY W. HALL, Manager

TELEPHONE "21 Cortlandt." Private exchange to all Departments.
REGISTERED CABLE ADDRESS: "Electview," New York.

TO ADVERTISERS

CHANGES for advertisements should be in this office by *Friday noon* for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than *Monday noon* to assure publication in that week's issue.

SUBSCRIPTIONS

One Year, United States and Canada $3.00
One Year, Foreign Countries 5.00
Single Copies, each 10

CONTENTS.

EDITORIAL:
Improvement in the Electrical Industries in Europe ... 423
The Electromagnet for Remote Control ... 423
An Electrical Method of Investigating Magnetic Problems ... 424
Directed Wireless Telegraphy ... 424
Radium as the Possible Source of the Sun's Energy ... 425
The Electrical Nature of Matter and Radioactivity, by Harry C. Jones ... 426
Automobile Exhibition in New York City ... 427
An Experimental Determination of Air-Gap Reluctance, by Charles H. Smoot ... 428
A New Type of Horn Lightning Arrester ... 430
Independent Telephone Association of Southern Indiana ... 430
The American Street Railway Association ... 430
The Hydraulic Plant of Bournillon, France, by C. L. Durand ... 431
Telephone Traffic, by Herbert Laws Webb ... 435
Welfare Work Medal ... 439
Radium the Source of the Sun's Energy, by G. H. Darwin ... 439
Atlanta Northern Railway ... 440
Directed Wireless Telegraphy ... 442
Harvard-Tech Merger Suit ... 443
Madison Square Garden Electrical Show ... 443
Fire at Niagara Power-House ... 443
ELECTRICAL PATENTS ... 444
Fusion of Glass by Electricity ... 445
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE ... 446
INDUSTRIAL SECTION:
Motors for Crane Service ... 448
The Closing of Bulkhead Doors by Electricity ... 449
New National Code Fuse Plug ... 450
Allis-Chalmers Company's Report ... 450
A Floating Exposition ... 450
The Olympic Club Clambake ... 451
Electric Light Plant in India ... 451
The Selection of Electric Power Arrangements for Shops ... 451
CURRENT ELECTRICAL NEWS ... 452

IMPROVEMENT IN THE ELECTRICAL INDUSTRIES IN EUROPE.

It is reported in the foreign technical journals that there is a decided improvement in the situation of the electrical industries of Europe. Many of the companies there are securing a good deal of work, and the effect of certain consolidations has been beneficial. Companies which recently paid little or no dividend expect to make a respectable profit this year. One of the large German works anticipates earning a dividend of eight per cent and another of five per cent, which is considerably better than the showing they were able to make a year ago. An important Swiss company expects to declare a dividend of eight and one-half per cent, and another of ten per cent, both of these being better than for the year before. The French companies are also looking up, and even Russia, in spite of her unfortunate situation, seems to be forging ahead electrically. The outlook is very encouraging and is a decided contrast to that of a short time ago when a general depression prevailed.

THE ELECTROMAGNET FOR REMOTE CONTROL.

In spite of its simplicity and the great force which can be developed by an electromagnet, this old device has until recently not shared the confidence of the engineer. Except when little or no work was to be done, such as, for example, that performed by a telegraph relay, other means were employed for carrying out operations at a distance from the operator. But now the electromagnet seems to be coming into its own, for it is finding a wide application in many industries.

The thing that stood most in the way of the electromagnet was ignorance. While, theoretically, we knew a great deal about magnets, practically our knowledge was deficient. Even to-day there is lacking, in accessible form, information regarding the best type of magnet for any specific duty, and just what can be expected of it. The general impression was that while a magnet could be designed which would give a very strong pull, this could not be a long pull and therefore the device could have but a limited use. There was also a feeling of uncertainty of the reliability of the electromagnet. Many who would not doubt the more delicate motor were not willing to trust the simpler and sturdier magnet. They could feel sure that closing a switch would cause the motor to start, but thought that an electromagnet should be in sight, because it might need a kick or a push to start it.

This unsatisfactory condition has been entirely changed of late. Many skilled designers have devoted their attention to electromagnets for specific duty. Some of these men, indeed, have used them for ten or fifteen years, and have always contended that, if properly designed, there is no difficulty in constructing a reliable, simple and inexpensive device. The effect of this work is now apparent, for we find magnets in use for many different purposes. There is the simple lifting form, so convenient for handling bulky or irregular masses of iron. There is the magnetic release brake, which releases the brake on a motor whenever the motor is started. We now have large oil-break switches which must necessarily be placed some distance from the point of control, which are operated by electromagnets; and there is the still prettier application of the electromagnet to the multiple-unit system of control, which, in its newer type, makes use of a number of magnets in place of a motor. Then there is the corresponding use in electric elevator control, in which the operating switches are placed in the machinery room—where they should be—and a master switch, carried on the car, controls them through electromagnets. These applications of the electromagnet, which are now being made so satisfactorily, are ones which might have been thought of twenty years ago, but which, strange to say, have remained until they are to-day the latest refinements in electric traction and electric elevator practice.

AN ELECTRICAL METHOD OF INVESTIGATING MAGNETIC PROBLEMS.

Certain of the magnetic problems presented to designers of electrical machinery are so complex as almost to baffle mathematical analyses. Often the best we can do in this direction is to make certain liberal assumptions and thus deduce expressions which, when tested, may be found to apply more or less accurately to actual conditions. One of these important magnetic problems is that of securing the proper distribution of flux in the air-gap of dynamo-electric machines. A great deal of labor and much ingenuity have been expended in investigating these questions; elaborate methods have been devised, and the technical journals and the transactions of the engineering societies contain a vast amount of literature on the subject. Unfortunately, in all such experimental work the method of investigating the problem is somewhat indirect. Instead of measuring magnetic flux or tracing paths of magnetic force, we measure currents or electromotive forces, and from interpretation of them endeavor to gain an insight into actual conditions. Another difficulty, or rather disadvantage, of such researches is that the work must be conducted on an actual machine, or at least upon a fairly elaborate model.

To get over these difficulties a number of suggestions have been made, and some of them have been tried. Some time ago a very beautiful method of studying magnetic flux was described before the Institution of Electrical Engineers, of Great Britain. The method involved the construction of a hydrodynamic model of magnetic fields, and the authors of the paper showed some beautiful figures obtained by forcing a viscous fluid through passages representing the magnetic path. At a certain point colored streams of the same liquid were introduced in order to make the lines of flow visible. While extremely beautiful, the method is rather complicated, and would probably be found troublesome in actual practice. The authors, however, were able to obtain, by means of it, useful constants for dynamo design.

A simpler method, suggested some time ago, but, so far as we can remember, not put into practice until recently, is described in a paper read recently before the Western Society of Engineers by Mr. Charles H. Smoot. This paper will be found on another page of this issue.

Mr. Smoot makes use of the similarity of the laws governing magnetic flux and electric currents and he studies his magnetic fields by plotting the lines of electric current flow and equipotential in a sheet of metal having the shape of the magnetic path. The particular work which Mr. Smoot undertook was the investigation of the magnetic distribution in the air-gaps of dynamos, and his model therefore consists of a metal templet having the shape of the air-gap and the interpolar space. Although the laws of magnetic flow and electric flow are similar, the mere substitution of an electric current for a magnetic flux does not simplify the problem, for it is just as difficult to trace the path taken through a large conductor by the current as it would be to trace the lines of force. Mr. Smoot, however, by an ingenious application of the law that equipotential lines are always at right angles to lines of force, inverts the model, so to speak, and makes the electrical investigation easy—that is to say, instead of passing a current along the templet in the direction taken by the magnetic flux, he sends it across and then traces out his equipotential lines. The results which he obtains agree well with the experimental deductions obtained in other ways, particularly with those of Messrs. H. S. Hele-Shaw, Alfred Hay and P. H. Powell, who used the hydrodynamic model referred to above.

The method developed by Mr. Smoot should be of considerable value in studying magnetic problems. In using it, however, several things must be remembered. The templet represents only a plane of the magnetic space, and for a complete understanding of any field, templets representing various sections of that space should be made. It should also be remembered that when the field explored contains a magnetizing coil, or if the iron of the circuit has appreciable reluctance, there will be different magnetic potentials existing at the edges of the plate. Further, the method, as applied by Mr. Smoot, requires that two equipotential surfaces be assumed, where the current may be introduced and led out, and this might not be easy in all cases. The method, however, as said before, should have considerable value, for the readings are not hard to obtain, the model is inexpensive and easy to construct, and can be altered in shape without difficulty. In one case mentioned in the paper, the distribution obtained was other than that desired, but by trimming the templet with a pair of shears, the necessary modification was easily determined.

DIRECTED WIRELESS TELEGRAPHY.

The gradual introduction of wireless telegraphy is making more pressing the solution of several problems presented by it. One of these is the devising of a secret system, and the second—allied closely to the first—is the finding of some method of preventing interference of two neighboring stations. Both of these problems would be much simplified if the entire wireless system of a country could be brought under the control of a single company, or of the government, though it is very doubtful if either of these methods would be favorable to the best development of the new art.

The simplest way out of the difficulty would be the devising of a satisfactory system of tuning. Stations could then be allotted definite frequencies, and those in neighboring localities would not interfere with each other. But it is not easy to tune a wireless receiving system so that it will not respond to vibrations differing slightly in pitch from its own, and it is also difficult to set up the simple harmonic vibrations which must be employed if one sending station is not to interfere with a neighboring one. Dr. John Stone Stone has made considerable progress in this direction, but a simple tuned system solves only the interference trouble, and does not necessarily give

secrecy, for any one wishing to catch a message not intended for him need only adjust his receiver to the proper frequency. The system may be extended so as to give practically absolute secrecy by combining a number of waves of different frequencies arranged so that the message will be received only at that station containing apparatus tuned to these several frequencies. As the combination can be changed at will, it is practically impossible for an outsider, if he does not know the key, to take a message. This system has yet to be put into commercial use, but it has been tried experimentally.

Another way out of the interference difficulty is to limit the direction in which the wave is sent out—in other words, to throw out from the sending station an electrical beam, and not, as is to-day done, distribute the waves to the four quarters of the globe. Artom some time since said that he had accomplished this to some degree by means of his so-called polarized wave. Descriptions of his system were somewhat indefinite, and further evidence is needed. He believes, however, that his wave travels out elliptically, rather than circularly, so that a station in the proper direction, 100 miles away, say, would receive the message clearly, while one at seventy-five miles, in another direction, would not get it.

A second method of directing the electrical wave would be to use a parabolic reflector, but this is impracticable because, to be effective, the mirror would have to be of vast dimensions.

There is still a third method, which has been suggested and tried by Dr. Ferdinand Braun, of the University of Strasburg. He employs two antennæ, or rather three, tuned to the same pitch, but vibrating slightly out of phase. He thus secures an amplification of the wave in one direction, a complete wiping out in the reverse direction, and interference, to a greater or less extent, sidewise. The development of this system was not easy, for it required exact tuning of the three oscillating systems and an exact shifting of the phase of one of them. It seems, however, to have been accomplished, not only in the laboratory, but through a transmission of about a mile, and a brief account of the work is given on another page of this issue. If this can be done with certainty it is apparent that an important development in wireless telegraphy has been made. There is no reason to expect any great stumbling-block in applying the system to longer distances. Indeed, by means of it messages should be sent over a given distance with a less expenditure of energy than with the systems now generally employed. The system, however, does not offer a complete solution of all wireless telegraph troubles. It does not prevent stations lying in the path of the beam from catching the message. Moreover, it would probably interfere with the operation of such a station. It is true that it reduces greatly the probability of trouble of this kind, but if two independent systems, even though employing the Braun method, should attempt to operate throughout the same district, trouble would be sure to arise at some point or other which could only be avoided by the use of a tuned system or through some understanding between the two companies.

The Braun system would be of use principally on land between fixed points. It could hardly be used for communicating with vessels at sea, for unless a complicated sending station were erected, which would enable the message to be sent out through any desired angle whatever, it would be possible to communicate with a vessel only when it lay within the speaking angle. Moreover, if the vessel were not in sight, a system which sends out its message over the whole surface of the water would have a decided advantage.

RADIUM AS THE POSSIBLE SOURCE OF THE SUN'S ENERGY.

This year the meeting of that important body—the British Association for the Advancement of Science—took place in South Africa, the meetings being divided into two sections, one held at Cape Town and the other at Johannesburg. At each of these meetings the president of the association, Professor G. H. Darwin, delivered an address, the second address being a continuation of the first. A week or so ago we commented upon the subject of the first presidential address, which was an attempt to show that the law of evolution, as proposed by Charles Darwin, was applicable as well to inanimate matter as to living organisms. In the second section Professor Darwin took up the theme again, and endeavored to show that the formation of the solar system could be explained in the same way, and that each planet represented merely a case of the survival of the fittest.

Perhaps the most striking part of this address was that in which Professor Darwin endeavored to bring into agreement the estimates of geologists and physicists of the age of the sun. The latter, knowing the sun's mass and the rate at which heat is being radiated from it, estimate that it is about twenty million years old. The geologists, on the other hand, working back from evidence obtained on the earth, put the age of the sun somewhere between fifty and one thousand million years. Agreement between the two bodies of men has seemed impossible, but now Professor Darwin believes that the way has been opened for a complete understanding. The discovery of radium has given us a material which contains far more energy than could be put into an equivalent mass of matter in the form of heat, or even as chemical energy. If we assume that action similar to radioactivity is going on in the sun, and this is the primary source of the sun's heat, an estimate of the sun's age based upon this hypothesis would put it more in agreement with that of the geologists. Radium thus extends its way to the science of astronomy, as it has already done with physics and chemistry.

It is pleasant to think that the sun is a good deal older than the physicists would have us believe, for if Professor Darwin's explanation is the correct one, it applies to the future as well as to the past. The sun must then possess far more energy than its apparent temperature would indicate, and it is gratifying to know that it will last many years longer than the physicist of the old school would have allotted to it.

THE ELECTRICAL NATURE OF MATTER AND RADIOACTIVITY.

BY HARRY C. JONES.

CHAPTER II.

THE DETERMINATION OF THE MASS OF THE NEGATIVE ION IN GASES.

The determination of the charge carried by the negative ion is of the very greatest importance. We have already considered the method for determining the ratio $\frac{e}{m}$ for the negative ion. If we can now determine e, the charge carried by this ion, we would know m, the mass of the negative ion.

One of the most ingenious experiments in modern physics has been devised by J. J. Thomson for solving this problem. The experiment is based on an observation made by Wilson, that gaseous ions, both positive and negative, can act as nuclei for the condensation of water-vapor, even if there are no dust particles present in the gas. If a given volume of a gas containing ions is allowed to expand, it cools itself, and a part of the water-vapor will condense around the ions, producing a fog or cloud in the apparatus containing the gas.

That the water-vapor actually condenses around the ions was proved conclusively by J. J. Thomson, by the following very simple experiment. Two parallel metal plates were placed about five centimetres apart in the vessel containing the gas which had been freed from dust. These plates were connected with the terminals of a battery, by which they could be charged to a difference in potential of about 400 volts. Ions were produced in the gas by passing Rœntgen rays through it.

If the gas was expanded before the plates were connected with the battery, condensation of the vapor took place, just as we would expect if the ions acted as nuclei around which the water-vapor would condense. If the plates are now connected with the battery and charged, the strong electric field would remove the ions from the gas, and if the gas were then subjected to expansion we would not expect any appreciable condensation to take place, and such is the fact. Thomson says that under these conditions the condensation is scarcely greater than in unionized air.

This experiment shows conclusively that it is the ions which serve as the centres of condensation of the water-vapor—a drop of water condensing around every ion if they are not too concentrated. If we knew the number of drops of water in a given volume of the gas, we would know the number of ions in that volume. It is, however, obviously impossible to determine the number of water particles in a volume of gas by any direct method. Thomson solved this part of the problem by using an equation deduced by Stokes, connecting the rate at which the particles fall with their size. If we represent by v the velocity with which the particles fall, by g the acceleration of gravity, by u the viscosity coefficient of the gas, and by a the radius of the drop,

$$v = \frac{2}{9}\,\frac{g\,a^2}{u}$$

By observing the rate at which the cloud settles we arrive at the value of v. Knowing v we determine at once the value of a, the radius of the drop. Knowing the radius of the drop we know its volume.

If we represent the mass of the water deposited by each cubic centimetre of the gas, by m, the number of drops in a cubic centimetre u is given by the following equation:

$$m = u\,\frac{4}{3}\,\pi\,a^3 \;\therefore$$

$$u = \frac{3\,m}{4\,\pi\,a^3}$$

The mass of water deposited from each cubic centimetre of the gas, m, must be determined indirectly. Thomson made use of the heat that is liberated when the water-vapor condenses around the gaseous ions. Knowing m and a we have all the data necessary for calculating u, the number of ions in a cubic centimetre of the gas.

We now know the number of ions in a given volume of the gas. It still remains to determine the charge carried by a single ion.

The whole number of ions both positive and negative in a cubic centimetre of the gas is u; v is the mean velocities of both positive and negative ions when subjected to unit electrical force. Knowing these quantities it is only necessary to measure the current carried by these ions across unit area, under an electric force F, in order to determine the charge carried by a single ion. If we represent the charge carried by a single ion as formerly by e, we have: $v\ \mathrm{F}\ u\ e$ = current through unit area. Measuring the current that passes through the gas, we know all of the above quantities except e, which is calculated at once.

In performing the condensation experiment it is necessary, as Thomson points out, to work with gases which contain only a comparatively small number of ions. When the conducting gas contains a large number of ions some of these are not carried down by the condensed water-vapor, as is shown by the fact that under these conditions a second expansion of the gas, which is no longer subjected to the ionizing agent, will produce still further condensation, demonstrating that it still contains ions that were not carried down by the first expansion.

The condition that the gas shall contain only a few ions is easily secured, especially when the gas is ionized by Rœntgen rays. Either a weak stream of the rays is allowed to pass directly through the gas, or the intensity of the rays is diminished by inserting thin sheets of certain metals, such as aluminum, in their path.

The earlier experiments showed that the values of e for air ionized by Rœntgen rays and for hydrogen gas ionized by Rœntgen rays are equal to within the limit of experimental error, which proves that the gaseous ion carries the same charge whatever the gas from which it was produced.

It was shown by Wilson that when the gas is expanded to 1.25 of its original volume only negative ions form nuclei for cloud condensation. This is also true when the expansion is as great as 1.3. For greater expansion than 1.3 both positive and negative ions are precipitated.

In the apparatus used in the earlier work, when the expansion was greater than 1.3, it was found that there were not twice as many cloud particles as when the expansion was less than 1.3, as there must be if all of both negative and positive ions were thrown down. This showed that some of the positive ions were not precipitated at the higher expansion, since all the negative ions, and only the negative ions, were brought down at the lower expansion.

A form of apparatus was then devised in which the expansion could be effected much more rapidly. With this apparatus the number of moisture particles or gaseous ions precipitated was just twice as great when the expansion was greater than 1.3 than when it was less than this value. This is just what must have occurred if all the positive ions were thrown down, since all the negative ions are precipitated at an expansion that is less than 1.3, and there are the same number of negative and positive ions in a gas.

COMPARISON OF THE CHARGE ON A GASEOUS ION WITH THAT ON A UNIVALENT ION OF AN ELECTROLYTE.

Having determined the magnitude of the charge on a gaseous ion we shall next

determine the magnitude of the charge carried by a univalent ion of an electrolyte —say the hydrogen ion.

We know that the number of molecules in a cubic centimetre of a gas, at a pressure of 760 millimetres of mercury and at zero degrees, is between 2×10^{19} and 1×10^{20}. We know the amount of electricity required to liberate this amount of hydrogen gas. The charge carried by the hydrogen ion in solution is somewhere between 1 and 6×10^{10}.

We thus see that the *charge carried by the gaseous ion is the same as that carried by the hydrogen ion in electrolysis.*

This conclusion is based upon a large amount of work with the ions produced from various gases and by various ionizing agents. We have already seen that *the value of* $\frac{e}{m}$ *for all of these gaseous ions is the same no matter what the nature of the gas from which they were produced,* and no matter what the nature of the ionizing agent. It has further been shown that all of these gaseous ions carry the same charge, and that this is the same charge as that carried by the hydrogen ion in aqueous solution.

We have now all the data necessary for calculating the relative masses of the gaseous ion, and the hydrogen ion in solution. The value of $\frac{e}{m}$ for the hydrogen ion in solution is 10^4. The value of $\frac{e}{m}$ for the gaseous ion is 10^7. The values of e in the two cases are the same. *Therefore, the value of m for the gaseous ion is about one-thousandth the value of m for the hydrogen ion in solution.*

More accurate determinations show that the relation between the masses of the gaseous ion and the hydrogen ion in solution is as 1 to 770.

It is difficult to overestimate the importance of this conclusion. In the first place, it is a matter of the very highest importance to establish the fact that the mass of the gaseous negative ion is always the same, no matter what the nature of the gas from which this ion is split off, and no matter what the nature of the ionizing agent. This has been shown to be true whether the gas is elementary or compound. This shows that a *common constituent can be split off from all gases no matter how widely they may differ chemically,* and what is perhaps even more important is that the *mass of this negative ion which can be split off from any gas is much less than the mass of the lightest so-called element known to the chemist.* The gaseous negative ion is, then, a common constituent of all matter, and is much smaller than the smallest atom known to the chemist, having a mass which is only about 1/770 of that of the hydrogen ion in solution, which, as we shall see, has practically, but not exactly the same mass as the hydrogen atom.

This unit of matter, so much smaller than the atom, and which is apparently common to all, carrying a unit electrical charge, or that charge carried by the hydrogen ion in solution, Thomson called a *corpuscle.*

THE RATIO OF THE CHARGE TO THE MASS FOR THE POSITIVE ION.

Before leaving this part of our subject a few words should be added in relation to the value of the ratio $\frac{e}{m}$ for the positive ion. These positive ions exist in the so-called "Canalstrahlen," discovered by Goldstein. They are also known as anode rays. Just as the cathode rays move from the cathode towards the anode, so there is a corresponding movement of matter towards the cathode. This can be detected by perforating the cathode with a number of holes, through which the "canal rays" pass and produce a phosphorescence where they fall on the walls of the glass tube behind the cathode.

Wien used a perforated iron cathode, and determined the value of $\frac{e}{m}$ for the rays which passed through his cathode. He used the method already described for determining the value of $\frac{e}{m}$ for the cathode particles. He deflected the rays by means of a strong magnetic field, and then in the opposite direction by means of an electrostatic field. A strong magnetic field is necessary to produce an appreciable deflection of the canal rays, and this renders the result less accurate. He obtained the following result:

$$\frac{e}{m} = 8 \times 10^2$$

He also found that these positively charged particles move with much smaller velocity than the negatively charged particles.

If we compare the value of $\frac{e}{m}$ for the negatively charged particles with that found by Wien for the positively charged particles in the above experiment,we will see that the value for the negatively charged particle is about 3.3×10^4 times the value for the positively charged particle.

Since the charge carried by the positively charged particle is the same as that carried by the negatively charged particle, it follows that the mass of the positively charged particle in the above experiment is of the same order of magnitude as the corresponding ion in solution.

We can, then, conclude that while the mass of the negatively charged particle in a gas is constant, independent of the nature of the gas, and very small as compared even with the mass of the lightest atom or ion in solution, the *mass of the positively charged particle is of the same order of magnitude as the corresponding atom or ion in solution in a dissociating solvent.* The mass of the positively charged particle is not constant for different gases, but, as we would expect if the positive ion is a charged atom, varies with the nature of the gas in question.

This beautiful work of Thomson on the conduction of electricity through gases makes it more than probable that a small particle which he calls the corpuscle is split off from the atoms of all gases, carries the negative charge, and is the same unit, no matter what the nature of the atom from which it separates.

The remainder of the atom from which the corpuscle has separated carries the positive charge, and is the positively charged ion in the gas. The *nature of this positive ion is different for every gas, being simply the atom minus the constituent common to all atoms, which is the corpuscle.*

It would be a tremendous step forward towards the solution of one of the greatest problems with which men of science have had to deal—*the ultimate nature of matter*—had Thomson gone on farther than what has been above developed. This is, however, but the beginning. Thomson has studied the nature of the corpuscle itself, and the result of this part of his investigation is certainly one of the most fascinating, and probably one of the most valuable contributions to modern science.

Automobile Exhibition in New York City.

The sixth annual automobile exhibition of the Automobile Club of America will be held in the Sixty-ninth Regiment Armory, Lexington avenue, Twenty-fifth and Twenty-sixth streets, New York city, January 13 to 20, 1906. The exhibition will be under the direction of the exhibition committee of the Automobile Club of America, 753 Fifth avenue, New York city.

AN EXPERIMENTAL DETERMINATION OF AIR-GAP RELUCTANCE.[1]

BY CHAS. H. SMOOT.

It is the aim of this paper to put forward a practical method of solving problems concerning magnetic reluctance and distribution, such as are continually confronting a designing engineer.

The fundamental law governing magnetic flux, potential and reluctance, is the well-known Ohm's law applied to magnetism, with flux substituted for current, potential for voltage and reluctance for resistance. When current flows in parallel straight lines through a conductor of uniform resistance its behavior can be readily calculated by the use of Ohm's law alone; this being the problem of the relation of current voltage and resistance for a wire of uniform section. Similarly the magnetic analogy of the relation of flux, ampere-turns and reluctance where the lines

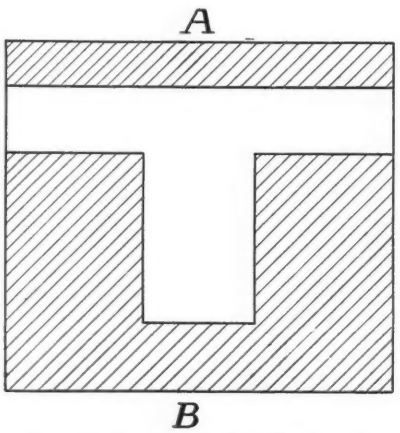


FIG. 1.—SECTION OF POLE-PIECE AND ARMATURE.

of flux are straight parallel lines and the conducting medium of uniform reluctance, can be handled with the aid of Ohm's law alone, as for instance in the air-gap of a dynamo with a smooth-core armature, but when the lines of current or magnetic flow are no longer straight parallel lines, each curved path of flux obeys Ohm's law, but before the law can be applied it is necessary to know what is the course of each flux path, its length and width.

Since electricity and magnetism obey the same fundamental laws it is obvious that under any given set of conditions their action will be the same. Hence it would appear that if we knew the electrical resistance of a certain odd-shaped space we could find its magnetic resistance. This is the case, and the method of procedure to convert electrical resistance into magnetic resistance is as follows:

First—Measure the resistance of a metallic template, the outline of which is a section of the air space in question.

Second—Measure the resistance of a simple rectangular template of the same metal. The ratio of these resistances is the same as the ratio of the magnetic reluctances for similar sections of air space.

Third—Calculate the magnetic reluctance of a rectangular air space, corresponding to the above rectangular metal template.

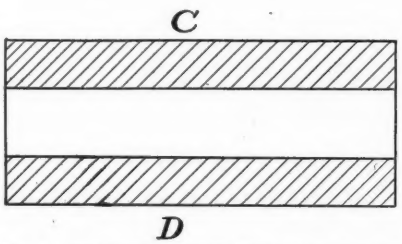


FIG. 2.—SECTION OF POLE-PIECE AND SMOOTH-CORE ARMATURE.

Fourth—Obtain the magnetic reluctance of the odd-shaped space by multiplying this reluctance by the ratio of the first to the second resistances above.

Fig. 1 is a section of a pole-piece and armature, one tooth pitch in length, and Fig. 2 is the same section but for a smooth-core armature. In these figures the shaded portions represent heavy copper plates, while the intermediate space represents a sheet of high-resistance metal in good electrical contact with the copper plates.

To determine the magnetic reluctance of the slotted core gap, one tooth pitch in length, calculate the reluctance of an imaginary gap with a smooth-core armature and multiply this reluctance by the ratio of the ohmic resistance from A to B to the resistance from C to D.

The size and material of these two templates are the same and they differ only in the presence or not, of the portion representing the slot.

In this problem, and in many others of a similar nature, the trouble incident to shaping the copper plates may be reduced or done away with altogether, by inverting the current flow in the template; that is, by substituting lines of current flow for magnetic equipotential lines, and *vice versa*. To cause this interchange through the body of the template it is only necessary to compel the interchange along the entire perimeter.

Figs. 3 and 4 are the same as Figs. 1 and 2 in all save that the boundary conditions are interchanged.

Under these conditions the ratio of resistance for the odd-shaped space to the rectangular space is the reciprocal of its former value; that is, ratio of resistance to be used in making magnetic calculations is now the reciprocal of the resistance from E to F to the resistance from A to H.

It is possible to give an absolute mathematical proof of this fact, but such a proof is out of place in this paper. It may be evident from the following, however:

Referring to Fig. 4, it is obvious that the resistance from G to H is proportional to L ÷ W, while the resistance from *a-b* to *c-d* is proportional to W ÷ L, so that for a rectangular space bounded by stream and equipotential lines only, the inversion of these boundaries gives a resistance which is reciprocal of its former value. Any odd-shaped space is filled with stream and equipotential lines which intersect at right angles so that the space may be considered as composed of a large number of little rectangles, for which the above law of the reciprocals applies. It therefore applies to the space as a whole.

Fig. 5 shows two sets of lines, either one of which may be a stream line or an

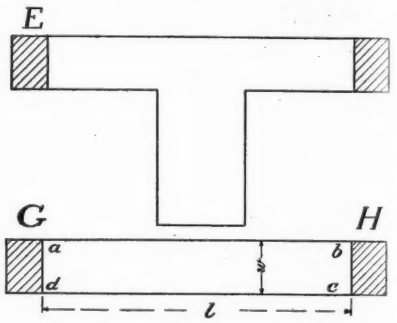


FIG. 3 AND FIG. 4.—INTERCHANGED BOUNDARY CONDITIONS.

equipotential line, according to which direction the flux takes. The lines have different names but the same positions, whether the flux flows from right to left or up and down. As shown in the sketch the spacing of these lines is uniform, that is, each adjacent pair of lines includes the same flux.

The problem of slotted armature air-gap reluctances is one of long standing. The most recent contribution to the subject is a paper before the Institution of Electrical Engineers, of Great Britain (November 24, 1904), in which a hydrodynamical method is described, where for magnetic flow is substituted the flow of a viscous fluid between plates of glass. One of these plates has a raised projection of paraffine of the same contour as the air space it is to represent, and which so restricts the passage between the plates that the resistance to flow is increased by an

[1] Paper read at a recent meeting of the Western Society of Engineers.

amount corresponding to the increase of magnetic reluctance of air space over iron. Fig. 6 represents a flux diagram obtained by the writer. The dash lines are stream lines which were obtained by

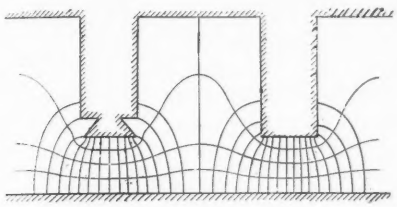


FIG. 5.—STREAM LINES.

the authors of the British Institution paper.

It is seldom necessary to have such a diagram as this for practical purposes. To obtain one, pass the uniform current through the template. Along an edge which is a stream line, mark off points representing a uniform difference of potential, using a millivoltmeter, then from each point trace the intersecting equipotential line. The current or flow lines may now be found indirectly as a series of lines perpendicular to the equipotential lines, or the current flow may be inverted

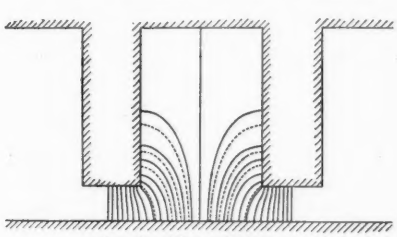


FIG. 6.—FLUX DIAGRAM.

and the flow lines found as equipotential lines for the inverted case.

Table 1 gives the ratio of slotted-armature to smooth-core, armature, air-gap reluctances obtained in various ways. Column A is the ratio of slot width to tooth width. Column B is the ratio of slot width to gap length. Column 1 is the ratio of slot to smooth-core gap reluctance, obtained from the inverse ratio of the resistance from E to F, to the resistance from G to H, in Figs. 3 and 4. Column 2 was obtained by the hydrodynamical method and presented in the British Institution paper referred to above. Column 3 was worked out by the same people from a mathematical analysis by Mr. F. W. Carter. Column 4 was determined by the writer from data deduced by Mr. E. Arnold, who obtained a curve and formula for gap reluctance by drawing arbitrarily various stream line maps for various slot and gap proportions, and for each map calculating the reluctance of the gap, taking finally as correct the minimum reluctance so obtained. Column 5 was obtained from an analysis of Messrs. C. C. Hawkins and R. Wightman, which is based on the approximation that all stream lines are either straight or are composed of part straight lines and part arcs of circles. This at best is a rough approximation. Inasmuch as all these values are calculated by means of a slide rule, the agreement of the first four columns is quite satisfactory and constitutes a good check.

TABLE NO. I.

A	B	Ratio of Slotted to Smooth-Core Reluctance.				
s/t	s/g	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
0.500	3.42	1.17	1.18	1.16	1.17	1.21
0.510	2.80	1.14	1.13	1.14	1.14	1.19
0.515	6.65	1.24	1.26	1.24	1.24	1.28
0.524	2.35	1.12	1.11	1.12	1.12	1.18
0.530	1.68	1.11	1.10	1.09	1.11	1.14
0.670	4.57	1.26	1.21	1.24	1.26	1.30
0.770	2.27	1.17	1.22	1.16	1.17	1.23
0.810	4.00	1.25	1.23	1.25	1.28	1.32
0.940	9.60	1.51	1.52	1.48	1.50	1.53
0.945	4.30	1.30	1.31	1.30	1.32	1.38
1.00	4.00	1.30	1.25	1.29	1.32	1.38
1.00	4.40	1.32	1.37	1.32	1.34	1.40
1.00	4.50	1.38	1.32	1.32	1.35	1.40
1.02	4.45	1.35	1.35	1.32	1.34	1.41
1.28	3.90	1.36	1.33	1.34	1.37	1.44
1.94	3.86	1.45	1.37	1.40	1.47	1.55
1.98	3.34	1.37	1.39	1.36	1.41	1.51

s/t = slot width ÷ tooth width. s/g = slot width ÷ gap length

These ratios apply to the ideal case where the pole-face is a plane surface and where both tooth and slot are rectangular with square corners.

Mr. E. Arnold's method and the hydrodynamical method are obviously laborious, while the sheet metal method is a simple matter, provided the necessary instruments are available. Furthermore, the sheet metal method will give accurate results for any shape of gap, slot and tooth that can be cut from a sheet of metal.

In applying this method to any problem which may come up, the following should be observed:

First—The metal template must be a true element of the space being investigated. A template of uniform thickness is only applicable to a space for which the flux map can be completely represented on a plane of two dimensions, such as the slotted core air-gap above. If the gap was the space between two coaxial cylinders separated by an air space, the metal template would have to be wedge-shaped, the thickness being zero at the axis of the cylinders and increasing uniformly with the distance from the axis.

Second—The boundaries of the template must be of the same character as the boundaries of the air space, that is, the entire boundary must be composed of stream lines and equipotential lines, which, line for line, correspond to the magnetic boundary, or all boundary lines must be interchanged.

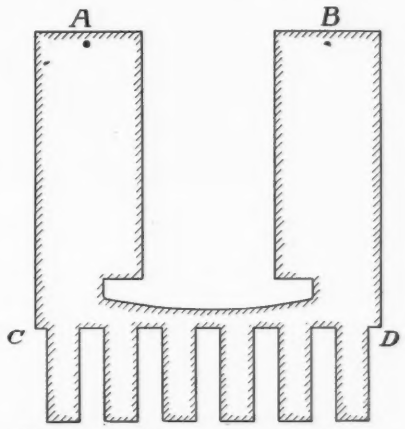


FIG. 7.—AIR-SPACE AROUND POLE-PIECE.

Third—The template may be cut along a current flow line without altering the distribution.

When designing an alternator having but few slots per pole and heavily champfered pole-pieces, which is the present standard practice for slow-speed alternators, the determination of the total air-gap reluctance is readily found by this method. In Fig. 7 is shown a sheet metal template representing the air space around a pole-piece extending to the centre of the inter-polar space.

To measure the reluctance of such a gap pass a current through the template from A to B, then measure the potential from C to D and calculate the apparent ohmic resistance. Then cut a rectangular strip from that part of the template representing the air-gap and measure the resistance of a given length. The ratio of these resistances is the inverse ratio of the corresponding air-gap reluctances. Since

the gap reluctance depends upon the relative position of pole-piece and armature, several such templates should be used and their average reluctance taken, say four templates, one for each quarter tooth pitch advance of the armature, or care should be taken that the relative position of the slots and pole represents an average value of reluctance.

The distribution of flux density may readily be found from a metal template. When a direct substitution is made of electricity in the template for magnetic flux in an air space it is obvious that at any point the current density will be proportional to the flux density. Current density is easily measured as a difference in potential per unit of length. In practice this may be done by connecting the terminals of a galvanometer to two steel points, which are attached to a stylus with a fixed separation.

When these points are in contact with

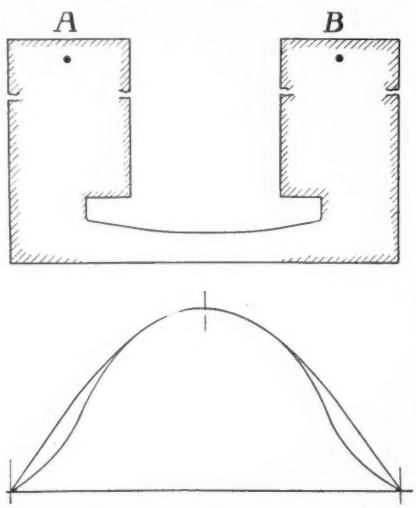


FIG. 8.—TEMPLATE FOR ALTERNATOR POLE-PIECE.

the templafe the galvanometer defection is proportional to the current density along a line passing through both points.

When an inverted substitution is made of electricity for magnetism the same means may be employed save that the line passing through the two galvanometer contact points will be along the inverted current line and therefore at right angles to their proper position, were the substitution direct.

Fig. 8 shows a template for an alternator pole-piece which was shaped so that its flux distribution curve would approximate a sine curve. The shape was determined by trial, and for each trial the flux distribution curve was found by passing a current through the template from A to B and measuring the potential drop per unit of length along the armature line. To change the shape of the pole-piece it sufficed to cut away from the template. This was done with tinner's snips and was directed by the shape of the flux distribution curve. Below the template in Fig. 8 is shown a sine curve and the actual flux curve which was finally obtained. Since this curve applies to a smooth-core armature it was left somewhat peaked because the presence of armature slots will act to reduce the peak and in an actual machine a still better approximation to a sine curve.

The analogy between the laws of magnetism and electricity has been known for many years, so that this method does not involve anything very new. In the course of preparing this paper the writer had occasion to look up the mathematical works of Mr. F. W. Carter and found that in 1900 he had suggested the possibility of working with sheet metal in much the same manner, although he had not actually done so.

Mr. E. Arnold's work is published in his "Die Gleichstrommaschine," vol. i, page 205. The British Institution paper by Messrs. H. S. Hele-Shaw, Alfred Hay and P. H. Powell was read before the Institution November 24, 1904, and has been reprinted in the ELECTRICAL REVIEW, December, 1904, vol. xlv, page 1049.

A New Type of Horn Lightning Arrester.

A British patent was obtained recently by Siemens Brothers & Company, of London, on a modified type of horn lightning arrester. In addition to the usual discharge gap formed of two diverging horns, one or more auxiliary gaps are employed. These auxiliary gaps are placed immediately below the main gap. They are fitted with pointed discharge electrodes, and are connected in series with resistances. When several auxiliary gaps are employed, the space between the lowest pair of points is the shortest, and the resistance in this circuit is the greatest, the space increasing and the resistance decreasing successively until the main gap is reached. When a discharge takes place, the arc is formed first between the lower pair of points. It rises until one end of the arc detaches from one of the lower points, and jumps to one of the next pair above. The arc is then formed between the second pair of points, and so on successively until it is finally broken at the main gap.

The Independent Telephone Association of Southern Indiana.

The sixth annual convention of the Independent Telephone Association of Southern Indiana, will be held at New Albany, Ind., on Monday, September 18, 1905. Mr. C. D. Knoefel is president of the association, and Mr. E. W. Pickhardt, Huntingburg, Ind., is secretary.

The American Street Railway Association.

The annual conventions of the street railway associations of the United States will be held in Philadelphia, Pa., the week of September 25. The American Street Railway Association will meet on Wednesday and Thursday, September 27 and 28. The American Railway Mechanical and Electrical Association will meet on Monday and Tuesday, September 25 and 26. The Street Railway Accountants' Association of America will meet on Thursday and Friday, September 28 and 29, and possibly on Saturday, September 30. The Claim Agents' Association will meet on Monday and Tuesday, September 25 and 26.

The following papers have been announced for reading and discussion before the American Railway Mechanical and Electrical Association: "Power Distribution," C. H. Hile, Boston; "The Power-Station Load-Factor as a Factor in the Cost of Operation," L. P. Crecelius, St. Louis; "Report of Committee on Controlling Apparatus," J. S. Doyle, New York, chairman; "Report of Committee on Way Matters," F. G. Simmons, Milwaukee, chairman; question box, edited by S. W. Mower, Detroit.

At the annual convention at St. Louis last year considerable time was devoted to the consideration of questions relating to a more complete and perfect organization of the American Railway Association and the various associations affiliated with it in street and interurban railway work. Power was given to the executive committee to arrange for meetings with the various affiliated associations and devise a plan for intimately connecting the various interests concerned. In pursuance of this policy a meeting was held at the Holland House, New York city, February 3 and 4, 1905. A committee was appointed to prepare a plan of reorganization. This committee has made a thorough examination of the scope, plan and methods of work of the more prominent organizations of a similar character throughout the country. Professor Henry H. Norris, of the department of electrical engineering, Cornell University, after making a complete and thorough investigation, presented a report before a joint meeting of the representatives of the affiliated associations held at the Hotel Bellevue-Stratford, Philadelphia, Pa., June 12 and 13, 1905. After some discussion this committee adopted an amendment to the constitution and by-laws, and recommitted them to a subcommittee for revision. This revision has now been completed, and the new constitution and by-laws will be ratified at the coming convention.

The Hydraulic Plant of Bournillon, France.

By C. L. Durand.

THE Isère district of France is one in which the use of hydraulic power for operating electric plants is continually developing, owing to the numerous falls which are available for this purpose. One of the most recent hydraulic stations is the large plant which has been erected on the Bourne river. It is intended to supply current by high-tension overhead line to different localities in the region, especially the towns of Vienne and Romans which lie twenty-five and forty miles off respectively. The Bourne river is a picturesque mountain torrent which has worn its way in the limestone rock, forming deep gorges in some places. At a point

FIG. 2.—PENSTOCK AND STATION, BOURNILLON HYDROELECTRIC PLANT.

above the present station it receives the water of an underground spring, which increases its flow considerably. The dam which is used to take off the water has been erected just below this point, and the water is brought by a canal and a penstock down to the station which lies in the valley. In this way a fall of some 102 metres is obtained, giving a capacity of 2,500 horse-power. Still further below the turbine station the river receives a second stream, the Bournillon, from which the plant takes its name, although in fact it does not use the water of this stream.

Later on, it is proposed to erect a second dam at an altitude of 200 metres higher up on the Bourne river and thus secure a fall of 300 metres. This fall is expected to give about 2,500 horse-power, but it will take off some of the supply from the present plant, which will thus be reduced to 1,500 horse-power. The main advantage of the second fall lies in the possibility of forming a storage basin of large capacity which can be turned to account in periods of low water.

Fig. 1 shows the dam and the hydraulic work on the Bourne, which here runs through a narrow gorge. The dam is a short one, as the passage is already barred in part by a high rock, which made the work easier. The water is brought from the dam by a canal which follows along

FIG. 1.—DAM AND GATES, BOURNILLON HYDROELECTRIC PLANT.

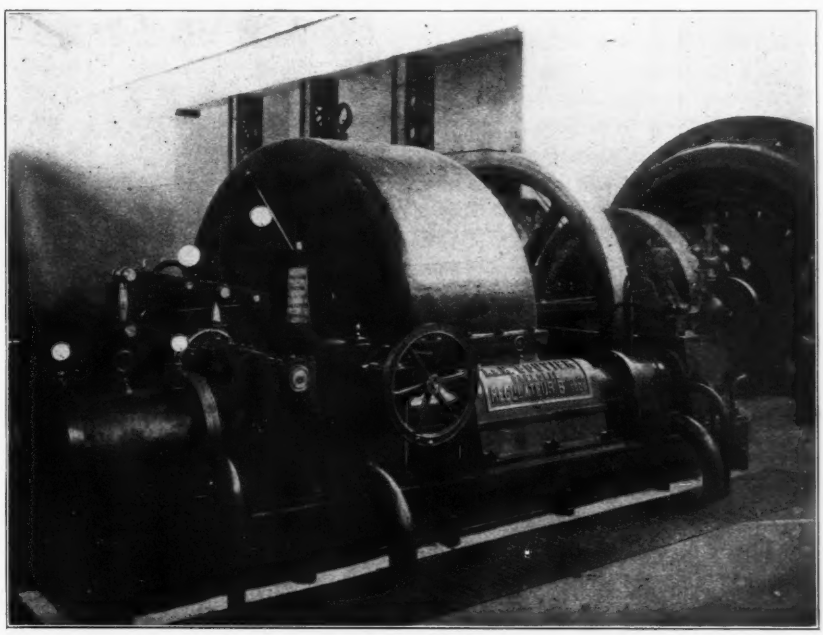


FIG. 3.—INTERIOR OF STATION, BOURNILLON HYDROELECTRIC PLANT.

the side of the river. It ends in a collecting-chamber at a point 1,800 metres down, which lies above the valley where the station is located.

A view of the turbine station at Bournillon is shown in Fig. 2. In the foreground is the penstock which runs from the water chamber down to the machines. The penstock, formed of riveted sheet steel furnished by Bouchayer and Viallet, has an inside diameter of 1.20 metres and the total length is 350 metres. When it arrives at the station the penstock turns at an angle and runs along the side of the building, where it has three feeding pipes for the turbines which are now placed in the station. It can be emptied by a discharge gate placed below, in case of stopping.

The dynamo room, of which Fig. 3 represents a general view, has been laid out to contain six direct-coupled dynamo groups with horizontal-shaft turbines, of 1,250 horse-power each. At present there are three of these groups erected in the plant. The Bouvier turbines, which are shown here, are of the most modern type and contain many improvements which contribute not a little to the successful running of the station. In Fig. 4 is shown a sectional view of one of the turbine and dynamo units. One point to be noted here is the use of a hydropneumatic device which recuperates part of the energy of the water leaving the wheel. It takes account of the height of the fall which exists between the floor of the machine room and the offtake canal. The apparatus introduces the quantity of air which is needed to keep up the water level in the lower tube leading from the wheel. In this way it is claimed that eighty per cent of the above-mentioned height is recuperated.

Before leaving the hydraulic part of the Bournillon plant we should mention the new type of speed regulator for keeping a constant speed at varying loads which has been designed by the Bouvier firm and is one of the main features of the system. The new regulator is designed to be an improvement over existing apparatus of the kind, and it is the first time that it has been applied on a large scale in a turbine station. In the regulator systems which are in use up to the present, the centrifugal governor does not act directly upon the mechanism which opens or closes the movable inlet vanes of the turbine so as to regulate the water supply according to the speed, but is connected with it by a relay hydraulic motor which does the actual work. The governor was connected to the motor by a mechanical device and the system thus formed had the disadvantage of possessing a certain inertia. The turbine gates were only adjusted to a new position after passing through a series of oscillations. In the present form, these oscillations are suppressed and the action is almost instantaneous.

The principal part of the regulating apparatus is a pump P (Fig. 5), which has a nearly constant rate of working. The

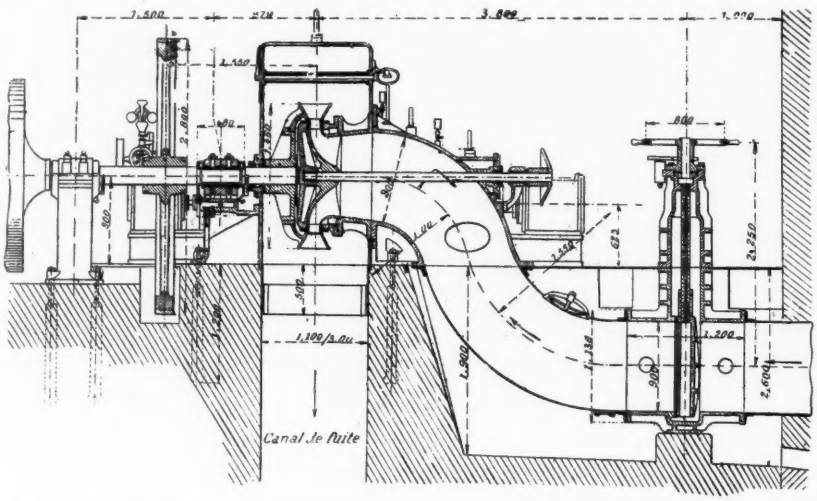


FIG. 4.—SECTIONAL VIEW OF TURBINE AND GENERATOR ARRANGEMENTS AT BOURNILLON.

pump keeps a liquid in circulation in the chamber in the direction of the arrows. The liquid rises in the pipe B, passes the pump and escapes into the chamber by the orifices KK which the valve S controls. The position of the valve is determined by the governor balls, which make it rise or fall. Thus for each position of the valve S, with the pump working at a constant rate, we will have a corresponding pressure H in the portions B and K of the system. When the speed of the governor balls increases, the section of the orifice is lessened and the pressure rises, and *vice versa*. Suppose that the pressure is made to work through the pipe *m* on a piston R, working against a spring *z*. The piston will then take a certain position which corresponds to each speed of the governor balls. If we connect the piston by means of T and V with the mechanism which regulates the turbine, we will have for any given speed of the governor only one position of the inlet vanes of the turbine.

Supposing the machines to be running at a uniform speed, and then that the load is suddenly thrown off. The speed tends to rise, but at the same time the governor acts upon the valve and cuts down the section at S. The pressure rises, pushing the piston R and closing the turbine vanes. This action on the vanes ceases at the exact moment when the motive couple becomes equal to the resistant couple. The pressure H ceases to rise, and the whole is balanced at a speed which is but little higher than at first. When a load is thrown on, the orifice at S increases, giving the inverse action. Thus each movement of the governor causes a corresponding movement of the turbine vanes, just as if it were directly operating them. By properly designing the parts, the apparatus can be made to keep the machines running at a nearly constant speed for all load variations. In the above method we thus pass from one load to another without losing any movement in the turbine vanes, but giving just enough to balance the system. While the piston R could act directly upon the turbines, in practice a relay hydraulic motor or differential piston is generally placed between

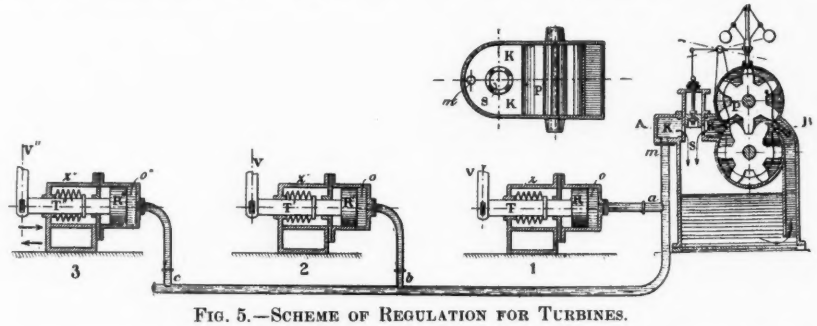


FIG. 5.—SCHEME OF REGULATION FOR TURBINES.

the two, so as to secure the desired force. The piston works the valve of the hydraulic motor and so controls it, and the motor follows exactly the piston's movement. The hydraulic motor can be operated by the main fall, or if this is not high enough, a storage tank fed by pumps can be used to supply it.

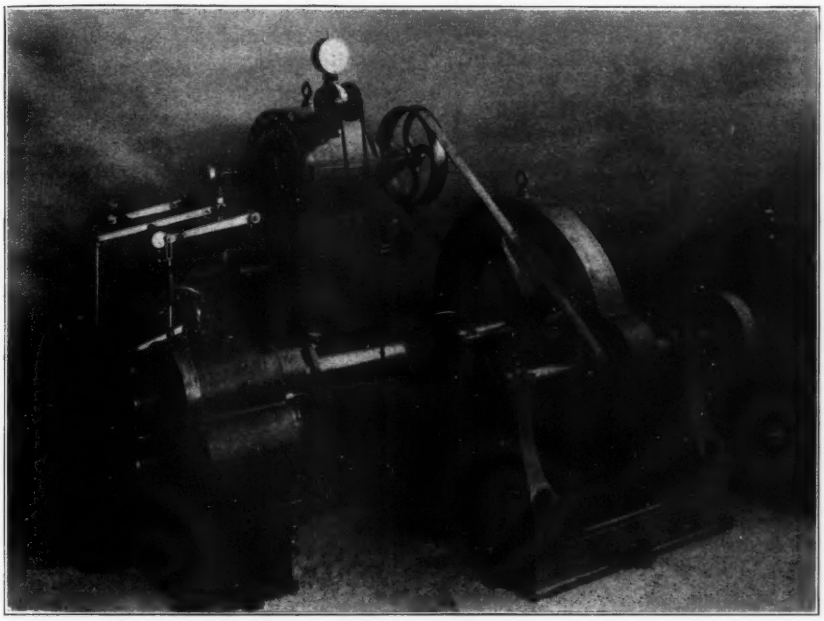


FIG. 6.—REGULATING APPARATUS, BOURNILLON HYDROELECTRIC PLANT.

One advantage of the system is that it can be used to give a simultaneous regulation to a set of turbines which are working alternators where the latter are coupled in parallel. The above figure shows how this is done. Here the regulator is applied to three turbines, V, V′, V″, each having a piston as described above. If the pistons are all alike and their springs well adjusted, all the turbines will take the same position for a given pressure of the liquid and the alternators will thus be run at the same speed. Should the turbines be of different sizes, this can easily be made up by giving the required adjustment to the springs.

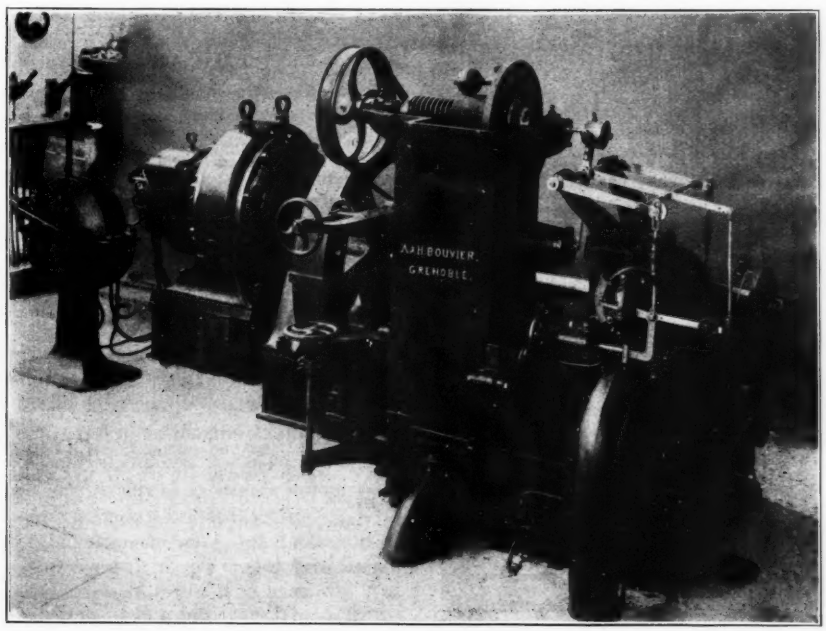


FIG. 7.—REGULATING MECHANISM, BOURNILLON HYDROELECTRIC PLANT.

In the Bournillon station a single centrifugal governor is made to regulate the speed of all the turbines at once, on the above principle. This apparatus, shown in Figs. 6 and 7, is worked by a synchronous motor which thus represents the speed of all the alternators running in parallel and takes the same variations. These variations are changed, as we have seen, into varying pressures which act upon all the turbines at once and secure a constant running.

The accompanying curves show the results of a series of tests which were made at the Bournillon plant in the presence of a committee of engineers and constructors. The present apparatus is calculated for a speed variation of five per cent under varying loads. The upper curves are those of a registering wattmeter for the loads, while the lower broken line shows the corresponding speeds. In the tests the loads were made to vary suddenly from zero to 1,250 horse-power, or the total capacity, while the speed, which is normally 375 revolutions per minute, did not vary more than five per cent. At each change of load, the turbine vanes took their new position without making any oscillations, which is characteristic of the Bouvier system. To avoid shocks in the water piping when the vanes are suddenly closed, a safety apparatus is provided, which allows a valve to open and give a side passage to the water around the turbine.

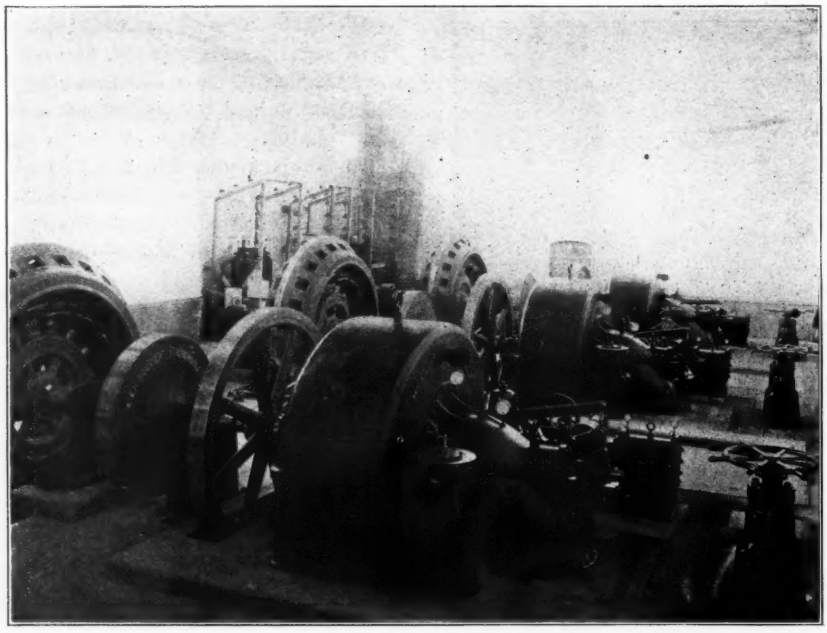
One of the engravings gives a general view of the main hall of the Bournillon station with the turbine and dynamo groups which have been installed there up to the present time. As the requirements for current in the region fed by the plant are likely to increase, space has been left for placing other groups of the same kind in the future. The groups which are now running consist of the above-described Bouvier turbines with their different regulating devices, also a flywheel of moderate size, each driving a three-phase alternator. An elastic coupler of improved pattern constructed by the Bouvier company is used to connect the turbine shaft with the alternators. The capacity of the turbines is rated at about 1,000 horse-power. The alternators have been furnished by the well-known firm of Schneider & Company, which, besides its large works at Creusot, France, is supplying electrical apparatus, including the present outfit, from a new factory at Champagne-sur-Seine. The three groups operate at a uniform speed of 375 revolutions per minute and the working voltage given by the machines is 3,800 volts. The output of each alternator is rated at 1,000 kilowatts. The voltage of 3,800 at fifty cycles is raised by a bank of transformers in

order to give a line voltage of 35,000 for the overhead high-tension circuits.

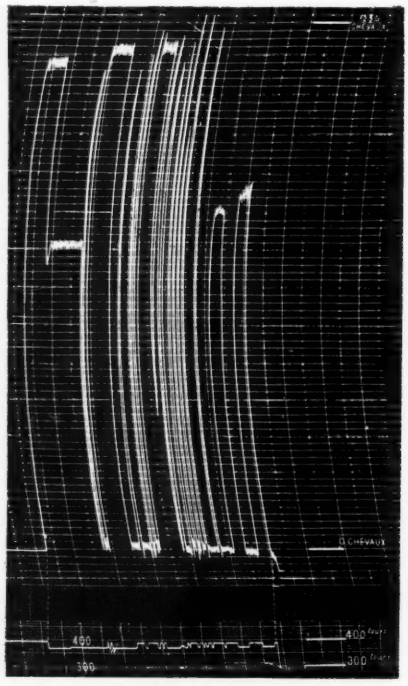
The alternators are of the type having the armature fixed and mounted in the outer casing, while the field-poles are mounted on the revolving part and driven from the turbines. In the case of the new Schneider machines one of the main features of the outer armature is the method which is used to support it and give a good centering with reference to the field. The armature casting is built in two conical-shaped pieces which are assembled by bolts. The casting holds the sheet-iron discs on the inside which form the magnetic circuit of the armature, in the usual way. The lower part of the casting descends beneath the floor level in a suitable pit, where it is provided with an adjustable support, and at each side of the pit there is a bracket support bolted down to the floor, in which the whole casting can turn about its centre in order to adjust it. Good means of ventilating the coils are secured by the numerous holes in the outer frame.

The armature coils which are laid in the slots consist of a number of turns of heavy copper wire carried in micanite tubes. The slots have been calculated so that the wave-form given by the machine is very near a sine curve. A star-connection is used for the three-phase circuits. The armature base is 2.20 metres. Below the machine is the pit, and out of danger, are the porcelain insulators which receive the main current cables and from these the current goes to the switchboard by conduits under the flooring.

A cast-steel drum mounted on the main shaft and carrying sixteen poles forms the field of the machine. The exciting current is furnished to each alternator by a small machine mounted on the end of the shaft. Two collecting rings with carbon brushes take the current into the fields.



TURBO-GENERATORS AND REGULATORS, BOURNILLON HYDROELECTRIC PLANT.



SPEED AND HORSE-POWER CURVES.

In these machines each bearing is supported on an independent bracket. On one side the bed-plate is enlarged so as to hold the exciter. The latter gives a current of seventy volts and 300 amperes.

As already mentioned, the current which is delivered by the machines at a voltage of 3,800 is raised by a set of step-up transformers in order to feed the overhead line. The transformers, which have been supplied by Schneider & Company, are six in number at present. They are arranged in two banks of three each to make the coupling for the three-phase circuits. Both the primary and the secondary sides are connected in delta coupling. The transformers have a capacity of 580 kilowatts each. They are constructed on the double-column pattern, and the magnetic circuit is formed of two vertical columns which are built up in the usual way of laminated plates, together with two cast-iron end-pieces. The latter serve to form the top and the base of the transformer. The laminated columns are provided with air-spaces for cooling. The upper cast-iron piece forms a simple magnetic yoke, but the lower piece is much larger and is hollow, serving as the base of the transformer and also to provide for receiving the air-blast for the cooling, which comes up from below. To this end each bank of transformers is placed over a conduit in the flooring and the air is furnished by a motor-driven fan of the Mortier type, one for each of the two banks. The motors run on four or five kilowatts and have short-circuited armature windings, being direct-coupled to the air fans and running at 1,450 revolutions per minute on the three-phase current from the machines reduced to 200 volts.

A word may be said as to the windings of the new Schneider transformers. While the secondary or low-tension circuit has but one set of fixed contacts, the high-tension winding is provided with two extra contacts, so that we have the regulation voltage of 35,000, then can obtain 32,500 and 30,000 volts from the other terminals. In this way the line voltage can be raised to keep up with the increased consumption of current at different times.

The high-tension circuit is placed on the transformers next to the core in order to reduce risks to the attendants in the station, and the low-tension winding is placed over this. The high-tension winding is formed of a series of separate coils which are lathe-wound and insulated with micanite. Each of the turns consists of several wires in parallel. The circular coils are placed on the two upright columns of the transformer, being separated from the iron by an insulating tube of large diameter. Over the coils is placed a still larger tube, and upon this is wound

the low-tension circuit. The insulating tubes between primary and iron and between the two windings are disposed so as to allow for a good air current which is furnished from the lower body of the transformer, so that the air circulates all through the coils and the iron. The secondary coils take a current of 132 amperes and the primary or high-tension coils, seventeen amperes.

An extensive set of switchboard apparatus has been installed in the Bournillon plant to handle the low-tension circuits of the machines and the high-tension lines which lead from the station. Without going into the details of this apparatus, we may mention that the switchboard has been installed in a separate room or gallery which faces into the dynamo room and lies about ten feet above the main floor. The iron framework which forms the front or low-tension board is faced on the side next the hall with ten marble panels, five in the upper and five in the lower range. Eight of the panels are used for the circuits of the alternators. The switches are mounted in the rear, while their handles are worked as usual from the front. The remaining two panels carry the indicating instruments for the feeders of the station and the low-tension switches of the transformers, motor switches and other apparatus. In the rear of the first board and separated by a passage is a second board or iron framework which is used to carry the high-tension circuits coming from the transformers. The high-tension fuses are well protected by marble partitions so as to prevent arcing across. A separate room is devoted to the lightning arresters of the station and there is a second set in another room which contains the terminals of the overhead high-tension lines. The lightning arresters are used in connection with liquid resistances carried in earthenware tubes.

The transformers are installed in two spaces or niches which lie just below the main switchboard and opening into the station. The high-tension circuits pass up to the switchboard through the floor where they are protected by thick glass tubes. The cables from the machines are brought to the transformers by a large conduit underneath the floor which is seven feet deep, so that the men can easily descend into it to look after the connections.

The station contains an independent direct-current group which is used for the lighting circuit of the premises. It consists of a Schneider machine coupled to a separate thirty-five-horse-power turbine which runs at 900 revolutions per minute. The machine has a capacity of seventy-five volts and 440 amperes. It is also used as a reserve for the exciter circuits. Another machine is a forty-kilowatt synchronous motor which runs on three-phase current at 220 volts. This is the motor which operates the common governor of all the turbines, as we have already seen above. It is of special construction, so that it can start up very quickly when under load.

TELEPHONE TRAFFIC.[1]

BY HERBERT LAWS WEBB.

I have always held that the study of the traffic is the most important part of a telephone man's work. The chain of reasoning which leads to this conclusion is simple. The sole object of a telephone system is to supply telephonic communication, and telephonic communication consists of hundreds or thousands, or hundreds of thousands, of daily telephone connections. Each connection consists of a certain number of operations, each operation involving a definite performance by apparatus and by a manipulator. Therefore the principal aim of the telephone engineer should be to put the apparatus and the manipulators in a position to execute those various operations with maximum accuracy and celerity. The efficiency—efficiency here meaning accuracy combined with celerity—of the individual connection is the object to be attained, and efficiency of the connection requires efficiency in each step.

Even if the result were solely the supply of the most effective service possible to the public, the accurate and rapid production of the individual connection should be the chief solicitude of the telephone engineer. But the matter goes much deeper than that. It affects the whole engineering design of the system, and it affects both the capital charges and the working costs. Any gain, however slight, in the accuracy or the rapidity of manufacturing the individual telephone connection is felt throughout the whole system It reduces the size of the plant in proportion to output and so reduces capital charges, and it reduces the amount of work done in proportion to output and so reduces working costs.

I have read somewhere a remark, attributed to a famous member of this Institution, which aptly illustrates the point. Sitting on a mountainside, he said—"I let fall this grain of sand, and the whole earth feels the shock." Telephone men might well use this as a text. If in a telephone system, where hundreds of thousands, sometimes even millions of operations are performed daily, we make any one of those oft-repeated operations more accurate or more rapid, the whole system feels the effect. The gain of a second, or of a fraction of a second, on an operation many times repeated each day, has, in a large telephone system, a cash value running into handsome figures.

The importance of the study of telephone traffic, then, can not be overestimated, and it is clear that the efforts of all who are engaged in the design and conduct of telephone systems are ultimately focused on the production of accurate and rapid telephone connections. There are many different functions to be performed in a modern telephone system, as there are in a modern battleship; but the true function of the battleship is straight and rapid shooting, and the true function of the telephone system is straight and rapid operating. The cook of the battleship does his share in straight and rapid shooting by keeping the gunners' digestion in order, and in the telephone system even the humble wayleave officer or the storekeeper has his indirect share in the production of accurate and rapid operating.

The improvements in telephone exchange apparatus during the past ten years have been revolutionary. The history of telephone exchange working, covering now about twenty-five years, may be roughly divided into two periods; one of about sixteen years, in which the apparatus was mainly experimental, and many different systems were tried, but none was produced capable of dealing with a large daily traffic with real accuracy and rapidity; and one of about eight years, in which there has been perfected and standardized apparatus, largely automatic in its working, capable of the greatest accuracy and rapidity in operation. In the old apparatus the percentage of error was very great, owing to the distances between the signals and the jacks and plugs they were related to, and owing to lack of definiteness in some of the signals—on many occasions they worked at the wrong time, and on others they failed to work when required to. With regard to rapidity of operating, the old apparatus was relatively slow in working for variety of reasons. The distance between the signals and the jacks and plugs imposed a certain strain on the operator's attention and memory, the replacement of signals occupied time, and the lack of definiteness of some of the signals and the total absence of some essential signals necessitated a certain amount of supervision of each connection by one or more apparatus to ensure a reasonably accurate and satisfactory service.

In the standard apparatus of to-day all these conditions have been changed. The use of lamp signals enables many things to be done which were impossible before. The prime advantages of lamp signals are that they are extremely compact, they have no working parts, and therefore may be placed in any position, vertical, horizontal, or at an angle; they are automatic in

[1] Paper read May 11, 1905, before the British Institution of Electrical Engineers.

action or self-effacing, since the signal disappears immediately the current is cut off; and finally, they give a much more positive and assertive signal than any form of indicator. These various qualities enable several radical improvements to be made. The signals are placed immediately adjacent to the jacks or cords they control, which, in large switchboards, is impossible with electromagnetic indicators; the line lamp is immediately above or below its corresponding answering-jack and the supervisory lamps are in line with the connecting cords and close to them. With this arrangement the operator loses no time and has to exert no brain-power in tracing the relation between the signal and its corresponding jack or cord. The difference in effect between the modern arrangement of directly associating the signals with their corresponding jacks and cords and the old arrangement of placing

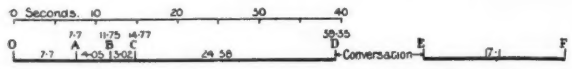


FIG 1.—PROGRESS OF LOCAL CONNECTION, MAGNETO SYSTEM.

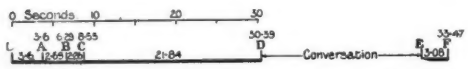


FIG. 2.—PROGRESS OF LOCAL CONNECTION, RELAY SYSTEM.

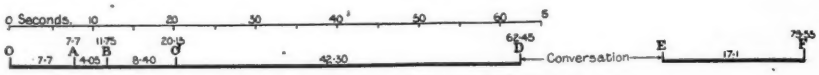


FIG. 3.—PROGRESS OF JUNCTION CONNECTION, MAGNETO SYSTEM.

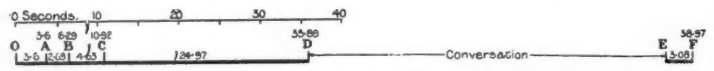


FIG. 4.—PROGRESS OF JUNCTION CONNECTION, RELAY SYSTEM.

the signals in a separate part of the board from that occupied by the jacks and cords is something akin to the difference between a telegram in plain language and one in code. In the one case the meaning of the signal flashes instantly to the brain of the operator, and in the other case a certain effort, and a certain interval of time, are required for translating the meaning of the signal. The automatic working of lamp signals is of much wider range than that of electromagnetic signals. We had self-effacing or automatically restored indicators before lamp signals were introduced. But the self-restoring indicator had but two positions—only two words in its vocabulary, so to speak. The lamp signal has several; it may be alight or out, corresponding to the down and up positions of the indicator, but it may also flash, and it may be made to flash at different rates of speed, easily recognizable. Therefore, apart altogether from the fact that it is much more easy to apply to lamps distinctive marks indicating different classes of service than it is to apply such marks to indicators, the lamp signal is able to convey a greater number of meanings as a working signal than an indicator. Finally, the more assertive and positive signal given by a lamp as compared with an indicator is due to a simple physical fact—the great sensitiveness of the eye to light. The glowing of a lamp signal instantly attracts attention, no matter at what angle the lamp may be relative to the eye, and in many cases the lamp is seen instantaneously where a fallen drop would be unnoticed for several seconds. The lamp is seen out of the corner of the eye, so to speak, whereas an indicator must be more directly in the range of vision.

Perhaps the most striking improvement in operating resulting from the use of lamp signals and the supply of energy from a central source is automatic supervision. In the older systems of working, as has already been said, the indefiniteness and unreliability of the signals made it necessary, in order to reduce as far as possible the percentage of error, that the operator should give each connection a certain amount of supervision. This supervision was directed to ascertaining that the two subscribers had got together all right, and later, in the many cases where the disconnection signal was not given, of ascertaining whether the subscribers had finished talking and the lines could be disconnected. This supervision demanded a certain amount of the operator's time on each connection in excess of the time actually required for the operation of the connection. In the modern switchboard the exact condition of the two subscribers' lines connected is shown by the state of the two supervisory lamps associated with the connecting cords. By the automatic working of these two signals the operator knows when the called subscriber answers, she knows when one subscriber hangs up and the other does not; she knows if either subscriber wants her to come in on the line, and finally she knows when the two have hung up. The operator sees these various conditions of the line by the action of the two lamps, and she requires to do no direct supervision. If either subscriber desires to attract her attention he flashes one of the supervisory lamps, by moving his switch-hook up and down, and it is only on this signal that the operator goes into the circuit. The automatic supervision and the automatic and definite disconnection signal afforded by the double supervisory signals constitute an immense advance in the means of handling telephone traffic.

In the working of junction lines—a branch of the operating which is of highest importance in large systems, since the greater proportion of the traffic passes over the junctions—great improvements have been effected by modern apparatus and methods. The use of lamp signals affords what was lacking before, a positive disconnection signal at the incoming end of the junction. The absence of such a signal was formerly responsible for many operating errors and for much extra work and waste of time. The existence of the supervisory lamp on the cord at the answering position enables the incoming junction operator to signal back automatically to the answering operator if the line wanted is engaged or out of order.

In the accompanying diagrams (Figs. 1 to 4), the average time occupied in the various steps of a connection between one direct line and another is shown by magneto working and for working with modern standard equipment.

The explanation of the diagram is as follows:

Zero being the starting-point at which the subscriber rings or takes his telephone off the hook, A is the point at which the operator has plugged in and answered, B the point at which she has taken and repeated the number, C the point at which she has tested the line wanted, plugged in and started to ring, and D the point at which the called subscriber answers. From D to E is the conversation, which is not shown on the diagrams, and F indicates the point at which the lines are disconnected after the conversation at E. It will be seen that the total time spent in operating a local connection with magneto working was 14.77 seconds from the beginning of the call to the moment when the operator began to ring the called subscriber, and 17.1 seconds from the end of the conversation to the moment when the operator disconnected the two cords. In the diagrams relating to junction calls the step B-C includes the time occupied by

the answering operator in speaking by call-wire to the junction operator and getting from her assignment of a junction and in plugging into the junction, and the time occupied by the junction operator in testing the line called for, plugging in and starting to ring; during the step B-C on junction connections work is being done simultaneously by the two operators at either end of the junction line.

There are several noticeable points in these diagrams. I should say first of all that the times given are the averages of many thousands of stop-watch observations made by trained observers with special signaling appliances attached to the lines under observation, and the figures indicate with great accuracy the actual average service received by the public. The service observed is that of New York city, where the working was at one time uniformly magneto, though with various types of equipment at different central offices, and is now and has been for the past three years uniformly relay, or common battery, with practically identical equipment at all central offices.

Taking the magneto service, the average time of disconnection, 17.1 seconds, seems long. The explanation is that on many occasions no disconnection signal was received by the operator, either because the subscribers failed to "ring-off," or because the signal failed to work. In such cases the operator would only learn that conversation had actually finished by supervision—listening-in. Such a measure being necessary on a large proportion of connections, a high average figure for the disconnection necessarily resulted. Similar conditions would be found on any magneto system to-day where the subscribers have not been rigorously trained to "ring-off."

A curious feature of the service with magneto working is the much longer time taken to complete junction connections, and the diagrams show that the called subscriber's answer was apparently eighteen seconds slower on junction than on local connections. As a matter of fact, the diagrams do the called subscriber a slight injustice; he really answers the call somewhat more quickly than the diagrams show. The explanation is that the operations on each connection are not strictly consecutive, as an operator usually deals with several connections at once. This results in breaking the strict continuity of the operations on a given connection; there occur short gaps in the train of operations on each connection, during which intervals operations on other connections are being performed. For the sake of clearness I have not attempted to illustrate this interweaving of operations, but have shown the various steps as if they were performed always consecutively. The natural tendency of operators is to complete local connections first; this slightly increases the gaps in handling trunk connections, and so makes the total time of operating, and apparent time of subscriber's answer, longer on junction connections.

The really striking features of the diagrams, however, are the great improvements in efficiency resulting from uniform relay working. It is seen that the local connection is operated in 8.55 seconds, as against 14.77 seconds, and the junction connection in 10.92 seconds as against 20.15 seconds, while the delay in disconnection is reduced from 17.1 seconds to 3.08 seconds, a substantial and important gain due entirely to the use of double supervisory signals.

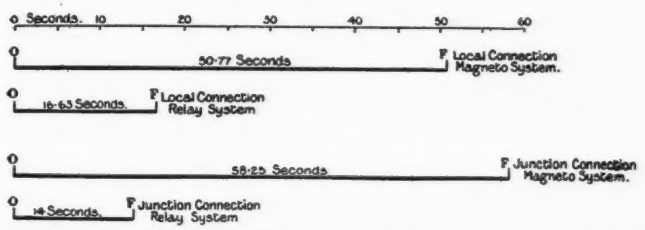


FIG. 5.—TOTAL OPERATING TIME PER CONNECTION, INCLUDING SUPERVISION AND RINGING. JUNCTIONS IN RELAY SYSTEM HAVE AUTOMATIC RINGING.

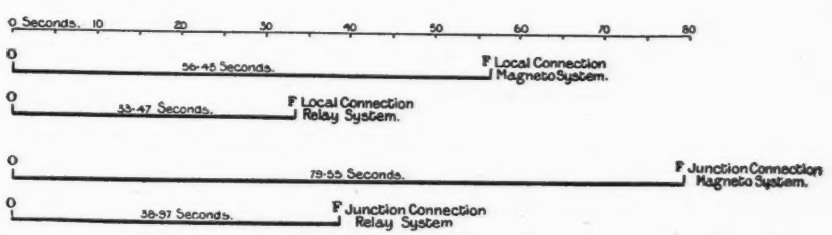


FIG. 6.—TOTAL TIME PLANT IS IN USE PER CONNECTION, EXCLUSIVE OF CONVERSATION

To show more clearly the gain in efficiency of operating with modern apparatus I have plotted in Figs. 5 and 6 the total time occupied in operating each class of connection under magneto and relay working, including supervision, and allowing five seconds for ringing, but eliminating the called subscriber's delay in answering, and, of course, the conversation. These diagrams show a very striking contrast between the results under old and modern methods. It is seen that the time spent in operating the average connection with standard apparatus is just a third of the time occupied with magneto apparatus; in junction connections the gain is even greater, the time spent in operating the average connection with standard apparatus being less than a quarter the average time with magneto apparatus.

These figures indicate that with the apparatus of to-day the operator should be able to do from three to four times the amount of useful work, that is, handle from three to four times the number of calls in a day that she was able to cope with ten or twelve years ago. It is impossible to give quantitative results of any exactitude, for a variety of reasons. The nature of the telephone call itself varies in different places; in some places there is hardly any junction work and the business is nearly all flat rate, making the average connection a very simple operation, while in other places there is much junction work, and a large proportion of the traffic consists of message rate calls, party line calls, call-office calls, and suburban and long-distance calls, which all have their quota of complication and extra work. Moreover, with the great increase in the use of the telephone during the past ten years there has arisen a corresponding increase in the fluctuation of the traffic—the busy hour is busier, the sudden rushes are more frequent and more accentuated—and it is the busy hour which, to a great extent, regulates the day's work of the operator in large exchanges, and the day's work of the junction line in large systems.

For all these reasons it is impossible to establish exact comparisons of quantitative results to prove that the whole gain in efficiency and economy indicated by these diagrams has really been utilized. That a large part has is unquestionable. One instance that has come under my notice, illustrating a very substantial gain in economy, may be mentioned; it is an exchange which formerly contained a mag-

neto equipment for 5,200 lines. The present switchboard equipment of standard apparatus is contained in a room of exactly the same size as the former room, indeed, built over it, and has a capacity of 9,600 lines. To show how difficult it is to make exact comparisons, I may mention that in the present switchboard the answering positions occupy about three-quarters of the space formerly occupied by the answering positions of the old board, whereas the incoming junction positions, though they are more economical, occupy more than twice the space formerly required for incoming junctions, so great has been the increase in the amount of junction traffic.

A saving in time in operating the average connection results in a more economical use of the plant in two ways: first, as the operator can handle more traffic in a day more lines can be terminated at a position, which means, as I have just indicated, a shorter switchboard for a given number of lines, with many attendant economies; and second, as the plant is used for a less amount of time on each average connection, the daily traffic-carrying capacity of the plant is increased. This has a direct effect on the economy of a very important part of any large system—the junction lines and their necessary switchboard equipment. It has also an effect in reducing the "engaged" trouble—that bugbear of all busy telephone systems. In Fig. 6 the diagrams illustrate the total time that the plant is employed in the unproductive part of the connection, the time that the plant is in use from the call to the second subscriber's answer, and from the end of the conversation to the disconnection. It will be seen that on the local connection the operating period on each connection has been reduced from 56.45 seconds to 33.47 seconds, a gain of 22.98 seconds, and from 79.55 to 38.97, a gain of 40.58 seconds on junction connections. Allowing an average of 120 seconds for the conversation, the result of shortening the time during which the plant is tied up on each connection by forty seconds is an increase of twenty-five per cent in the traffic-carrying capacity of the junction plant.

IMPORTANCE OF TRAFFIC STUDY.

It must not be imagined that the great increase of efficiency shown by these diagrams is due solely and entirely to improved methods of signaling and improved apparatus generally. It is also due to more efficient operating and a more thorough study of the minutest details involved in the handling of telephone traffic. It remains true, however, that the improved apparatus is the fundamental cause of the increased efficiency, for with the standard apparatus of to-day we not only get signals having definite meanings, and so eliminate a fundamental defect from telephone switchboards, but we get absolute uniformity of working, and so are able to train operators more effectively and more systematically. We give the operators better tools to work with, tools which involve less mental labor and less physical labor, and we are able better to teach the operators how to use those tools most effectively, both because the whole group of apparatus has become more scientific, and because the study of all the features of telephone traffic has become more scientific. The gain in efficiency of the telephone connection would be much less than it is if the introduction of accurate and automatic apparatus had not been accompanied by the adoption of systematic methods of instructing and training operators, of supervising their work and of continuously observing and testing the service. The preliminary training of operators is a most important point in a large and complicated system. In the old days, with a variety of types of equipment in use in the different exchanges, it was impracticable to establish a really effective training school. To-day, with uniform equipment in all exchanges, a training school where the embryo operator learns her work by the practical manipulation of the same appliances as she will handle in the regular exchange is a most natural institution. At such a training school more progress is made in a month in turning out an efficient operator than was formerly made in three months by the method of letting learners listen-in at a working position and gradually pick up the work by experiment. In any large system a training school is absolutely necessary for teaching operators the general methods of the work, the proper terms to use, the geography of the exchange districts, and so forth, but the course is relatively ineffective unless it includes practice with the actual appliances the operators are to handle, and practice in answering and completing calls, thorough practice of this kind is difficult to give unless the exchanges have a uniform type of equipment.

The general supervision of the service becomes much more effective with standard apparatus, because the lamp signals are much more easily observable by the supervisors than indicators are. Standing behind the operators at a relay switchboard one can practically follow every movement of the subscribers' telephones; a line signal unanswered or a pair of supervisory signals unattended to glare insistently until the operations demanded are performed. The supervisor's attention is instantly called to any unusual rush of calls, to any difficulty or delay.

The constant observation of the traffic is the measure which has contributed most to the effective use of modern apparatus, and to the attainment of a high standard of efficiency and accuracy in the operation of a large daily volume of telephone traffic. It is only by making continuous tests on a certain proportion of the daily traffic, noting not only the time of every step, but the method and manner of conducting every part of the operation, that sufficient information can be gained of operations involving so much detail to enable defective methods of operating to be eliminated or checked, and suggestions to be evolved tending to a general increase of efficiency.

Some idea of the complexity of telephone traffic may be had from the fact that the form for recording these service observations contains forty-two columns, each with its appropriate heading. An entry in each of these columns would not be made for a single call, but the test of one connection might require notes in a fair proportion of the columns, and even if but very few entries are made, each test or series of observations contributes its quota of information relative to the speed, the accuracy, and the general efficiency of the service. To set all these observations out on a diagram would hardly be interesting, and I will only say that the observations give the time, in seconds and fifths, of every step of the connection, the result of every connection, whether effectice or ineffective, and if ineffective from what cause—engaged, don't answer, cut-off, wrong number, subscriber left instrument, etc.—the mistakes and omissions of the operator or the subscriber, for even telephone subscribers are known sometimes to make mistakes—and in short, every ordinary vicissitude that the telephone connection is subject to. The information gained by a large number of tests of this kind, in which observation is made of every detail in the brief history of the telephone connection, is of enormous value in bringing to light the weak spots in the service, whether they be due to defects or faults in the plant, to slowness, inattention, lack of cooperation or lack of method, or erroneous methods on the part

of the operators. I hardly like to hint that there may be sometimes lack of method or erroneous methods on the part of the users of the service, who may thus contribute to the errors and delays which sometimes occur in the daily stream of telephone traffic; but if there be, continuous service observations will reveal them, and measures may then be taken to suggest such reforms as seem advisable.

To secure speedy and accurate operation of the vast volume of traffic which flows daily through a large telephone system requires first, that the apparatus used have signals of definite meaning, that the working of the apparatus be largely automatic, and that the apparatus be of uniform type throughout the system; second, that the operators be thoroughly trained in the manipulation of the apparatus and in the methods of dealing with all varieties of calls before being entrusted with the conduct of actual traffic; third, that the operators be continuously trained to active cooperation with each other, so as to produce general efficiency, and to accuracy and method in every detail; fourth, that a constant study be maintained of the actual conduct of the traffic, directed to the improvement of the standards of accuracy and speed.

Welfare Work Medal.

The International Exposition of Social Economy, being held at Liege, Belgium, has notified the New York Telephone Company that it would receive a silver medal in recognition of its welfare work among its employés. The company's methods of caring for the comfort of the telephone operators drew the highest praise from the officers of the exposition. The telephone company has seventeen exchanges in Manhattan. It employs in all about 2,500 operators. In each of the exchanges a suite of rooms has been set aside for the exclusive use of the young women. The suites include locker rooms where each girl may keep her effects under lock and key; a general sitting room supplied with the latest magazines, and a sickroom supplied with an emergency medical outfit. In a thoroughly equipped dining room tea and coffee are served free of charge. The quarters are in charge of a matron, who looks out for the comfort of the girls. Half-hour relief periods morning and afternoon give the operators time to enjoy the homelike surroundings. This relief from the strain of their work helps greatly to keep the girls in good health, and adds to their efficiency, so that the company feels that the investment has been a paying one, aside from the question of humanity.

RADIUM THE SOURCE OF THE SUN'S ENERGY.[1]

BY G. H. DARWIN.

If, as has been argued, tidal friction has played so important a part in the history of the earth and moon, it might be expected that the like should be true of the other planets and satellites, and of the planets themselves in their relationship to the sun. But numerical examination of the several cases proves conclusively that this can not have been the case. The relationship of the moon to the earth is in fact quite exceptional in the solar system, and we have still to rely on such theories as that of Laplace for the explanation of the main outlines of the solar system.

I have not yet mentioned the time occupied by the sequence of events sketched out in the various schemes of cosmogony, and the question of cosmical time is a thorny and controversial one.

Our ideas are absolutely blank as to the time requisite for the evolution either according to Laplace's nebular hypothesis, or the meteoritic theory. All we can assert is that they demand enormous intervals of time as estimated in years.

The theory of tidal friction stands alone among these evolutionary speculations in that we can establish an exact but merely relative time-scale for every stage of the process. Although it is true that the value in years of the unit of time remains unknown, yet it is possible to determine a period in years which must be shorter than that in which the whole history is comprised. If at every moment since the birth of the moon tidal friction had always been at work in such a way as to produce the greatest possible effect, then we should find that sixty million years would be consumed in this portion of evolutionary history. The true period must be much greater, and it does not seem unreasonable to suppose that 500 to 1,000 million years may have elapsed since the birth of the moon. Such an estimate would not seem extravagant to geologists who have, in various ways, made exceedingly rough determinations of geological periods.

As far as my knowledge goes I should say that pure geology points to some period intermediate between 50 and 1,000 millions of years, the upper limit being more doubtful than the lower. Thus far we do not find anything which renders the tidal theory of evolution untenable.

But the physicists have formed estimates in other ways which, until recently, seemed to demand in the most imperative manner a far lower scale of time. According to all theories of cosmogony, the sun is a star which became heated in the process of its condensation from a condition of wide dispersion. When a meteoric stone falls into the sun the arrest of its previous motion gives rise to heat, just as the blow of a horse's shoe on a stone makes a spark. The fall of countless meteoric stones, or the condensation of a rarefied gas, was supposed to be the sole cause of the sun's high temperature.

Since the mass of the sun is known, the total amount of the heat generated in it, in whatever mode it was formed, can be estimated with a considerable amount of precision. The heat received at the earth from the sun can also be measured with some accuracy, and hence it is a mere matter of calculation to determine how much heat the sun sends out in a year. The total heat which can have been generated in the sun divided by the annual output gives a quotient of about twenty millions. Hence it seemed to be imperatively necessary that the whole history of the solar system should be comprised within some twenty millions of years.

This argument, which is due to Helmholtz, appeared to be absolutely crushing, and for the last forty years the physicists have been accustomed to tell the geologists that they must moderate their claims. But for myself I have always believed that the geologists were more nearly correct than the physicists, notwithstanding the fact that appearances were so strongly against them.

And now, at length, relief has come to the strained relations between the two parties, for the recent marvelous discoveries in physics show that concentration of matter is not the only source from which the sun may draw its heat.

Radium is a substance which is perhaps millions of times more powerful than dynamite. Thus it is estimated that an ounce of radium would contain enough power to raise 10,000 tons a mile above the earth's surface. Another way of stating the same estimate is this: the energy needed to tow a ship of 12,000 tons a distance of 6,000 sea miles at fifteen knots is contained in twenty-two ounces of radium. The Saxon probably burns five or six thousand tons of coal on a voyage of approximately the same length. Other lines of argument tend in the same direction.

Now we know that the earth contains radioactive materials, and it is safe to assume that it forms in some degree a sample of the materials of the solar system; hence it is almost certain that the sun is radioactive also.

This branch of science is as yet but in its infancy, but we already see how unsafe it is to dogmatize on the potentialities of matter. It appears, then, that the physical argument is not susceptible of a greater degree of certainty than that of the geologists, and the scale of geological time remains in great measure unknown.

[1] Excerpt from the address by the president of the British Association for the Advancement of Science, Johannesburg, South Africa, August 30.

Atlanta Northern Railway.

The First Single-Phase Railway in the South.

ON JULY 17 last, the Atlanta Northern Railway Company opened its line between Atlanta and Marietta, Ga., and the largest interurban electric railway in the South was added to the steadily growing list of roads employing the single-phase alternating-current system developed by the Westinghouse Electric and Manufacturing Company. Since the commencement of service, exceptionally large crowds have at times been transported and the successful operation of the line is assured.

The company operates some fifteen miles of track between the terminal cities of Marietta and Atlanta and enters the latter city over the track of the Georgia Railway and Electric Company. The interurban line, however, is operated entirely independently and makes no attempt to conduct a local service.

Marietta, the northern terminus of the line, is located at the foot of the Kanasaw mountain, made famous during the Civil War by one of the battles of General Sherman, and now the site of a national cemetery. The intervening country is rolling and is devoted largely to the raising of cotton. The line crosses the Chattahoochee river at Iceville and passes through the villages of Smyrna, Gilmore and Butler. It is constructed over a private right of way which runs parallel to the track of the Western & Atlantic Railroad.

The track construction is exceptionally good, consisting of seventy-pound T-rails laid on ties which are ballasted with slag shipped from the iron furnaces of the Birmingham district. The maximum grade is three per cent and the shortest curve has a radius of 574 feet. The gauge is standard, *i. e.*, four feet eight and one-half inches. Within the limits of Atlanta, girder rails are used.

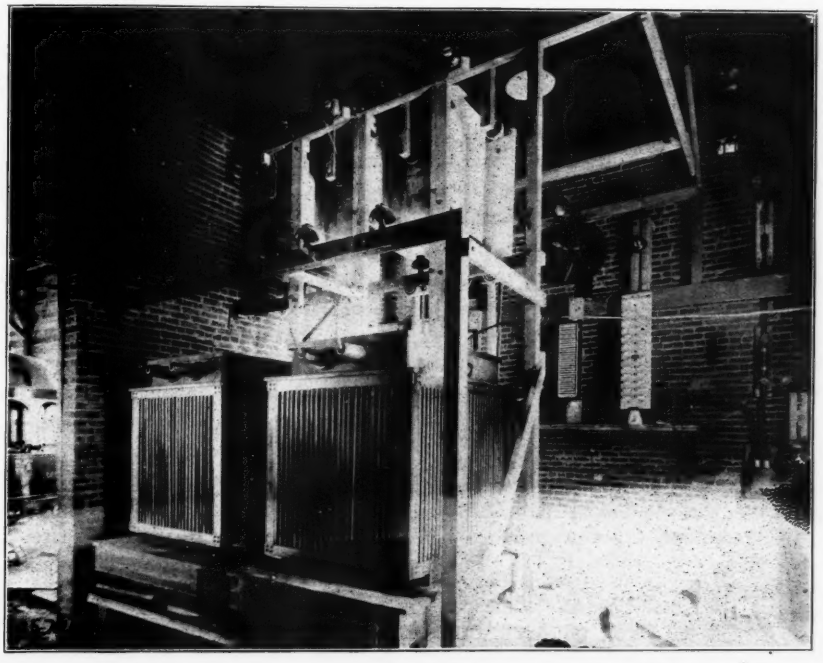
Except within the city limits of Atlanta, a single No. 000 trolley wire forms the entire low-tension distributing system. This is fed with twenty-five-cycle, single-phase alternating current at a potential of 2,200 volts. The trolley wire is suspended from cross spans secured to wooden poles set ninety feet apart on straight track and about forty-five feet apart on

A Cut on the Main Line of the Atlanta Northern Railway.

curves. The construction is similar in general to that ordinarily used in direct-current practice except that specially heavy insulators suitable for the higher voltage are employed.

The current supply for the new railway is obtained from the water-power station of the Atlanta Water and Electric Power Company about eighteen miles from Atlanta and is transmitted at a potential of 22,000 volts. The power equipment at the water-power station includes Westinghouse three-phase, twenty-five-cycle alternators with an aggregate capacity of 10,500 kilowatts. In case of accident to the water-power station, current may be obtained from a thoroughly equipped steam-power plant which the Georgia Railway and Electric Company, which also obtains power from the water-power station ordinarily, has in reserve for the operation of its lines in the city of Atlanta in emergencies. Few railways in any part of the country are so well provided with duplicate power apparatus for maintaining the operation of the road at all times. The trolley line is divided into three sections, each fed from one leg of the three-phase transmission system through oil-insulated self-cooling transformers. There are two transformer stations in each section connected to the same phase, making a total of six stations located approximately three and one-half miles apart. One of these is in Atlanta, one in the car barn near the limits of Atlanta, and the remainder at the towns of Bolton, Gilmore, Smyrna and Butler.

The transformer stations are well constructed of brick and each is equipped with one 150-kilowatt Westinghouse, oil-insulated self-cooling transformer, together with the necessary lightning arresters, choke coils, switches and fuses.

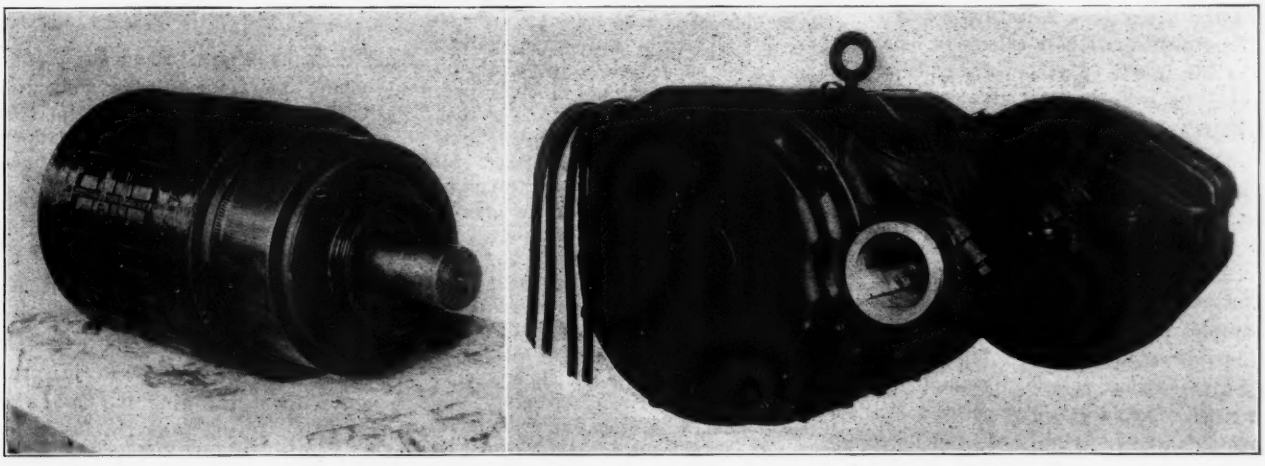


TWO 150-KILOWATT TRANSFORMERS IN STATION AT CAR BARNS, ATLANTA NORTHERN RAILWAY.

SINGLE-PHASE CONTROLLER FOR FOUR FIFTY-HORSE-POWER SINGLE-PHASE RAILWAY MOTORS.

The transformer in Atlanta and one of those in the car barn supply the 550-volt section of the trolley, and in order that all transformers may be interchangeable all are wound so the secondary voltage of either 2,200 or 550 may be used. Since these stations contain no moving machinery, no attendants are required. An occasional inspection of the stations is all that is necessary.

To ensure regularity of service with a minimum of reserve capacity, each transformer is mounted on a low truck and is



ARMATURE AND COMPLETE MOTOR AND GEAR CASING, FIFTY-HORSE-POWER, SINGLE-PHASE, RAILWAY MOTOR.

installed in the transformer station on a platform at the height of a standard flat car. A reserve transformer is held in the car barn mounted on a similar truck and loaded upon a flat car ready for instant transportation to any part of the line. This outfit serves as a reserve unit for all of the stations. In case of a breakdown or other trouble at any station, the crew of the first car discovering the difficulty would notify the car-barn force, who would then have the flat car hauled to this point and on arriving would roll the damaged transformer and its platform on to the flat car and replace it by the reserve unit. The arrangemen is ingenious and well thought out and indicates the ability of the engineers of the Atlanta Northern Railway Company who have planned and constructed the system in so thoroughly modern a manner. As each transformer station is capable of carrying the entire load of its section, practically a duplicate installation has been made. With this arrangement and the reserve unit described above, there is little likelihood of cessation of service because of failure of the power supply.

The rolling stock comprises six passenger and one freight car, four cars being employed in regular service to maintain a half-hour schedule between terminal points. The running time is forty-five minutes each way including some twenty stops. During the heavy rush hours, 189 passengers have been carried on a single car.

The passenger cars measure fifty feet six inches over all, and weigh about thirty tons each. They have a seating capacity of fifty-six persons. The cars were built by the Cincinnati Car Company and are mounted upon Brill 27-E trucks. The freight car was also constructed by the Cincinnati Car Company and is mounted upon standard trucks of the manufacturer. All cars are of the double-truck type with twenty-eight feet between truck centres.

The passenger cars are equipped with quadruple Westinghouse No. 108 fifty-horse-power motors. The equipment of these cars is remarkable for its simplicity. The circuit from the trolley passes to an autotransformer through a double-throw oil-switch which connects it to either one of two taps on the high-tension winding of the transformer according to whether 2,200 or 550 volts is used on the trolley. After leaving the autotransformer, the circuit passes directly to the ground. The motors may be connected to various taps on the low-tension winding of this transformer, giving five different running points.

The connections are made by a drum-type controller mounted on each platform. The motors may be run continuously on any one of the five notches, so a wide range of running speed may be secured.

The freight car is equipped with four No. 108 motors similar to those used on the four passenger cars with hand control, but in order that this car may be operated on any part of the city system, as well as over the company's own tracks, the control is arranged for operation on either direct or alternating current. There are, therefore, three operating conditions which can be met by this car. It can be run from a standard 550-volt, direct-current trolley, the 550-volt, alternating-current trolley in Atlanta and the 2,200-volt, alternating-current trolley between Atlanta and Marietta. To meet these widely different conditions, a combination of rheostatic and voltage control is used instead of pure voltage control as on the passenger cars. The motors are connected permanently two in series, and the two groups thus formed may be connected to any one of three different taps on the transformer. In starting the car, the motors are connected first to the lowest tap, then to the middle tap through a resistance, next to the middle tap without the resistance, then to the highest tap with the resistance in circuit, and, finally, to the highest tap with the resistance short-circuited. With this equipment, three different running points are obtained.

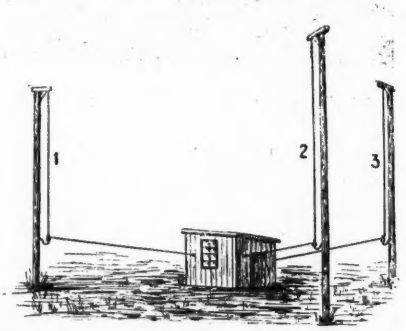
When operating on direct current, the motors are connected all four in series and rheostatic control only is used. There are thus four resistance points in addition to the "full-on" position.

Current is collected from the trolley wire by means of wheel trolleys of the ordinary type except that these trolleys are mounted on porcelain insulators on account of the high voltage which is used. Each car carries two trolleys, one at each end, and is equipped with Westinghouse straight air-brakes, the compressors for which are operated by series-wound motors similar in general to the main car motors. Nothing necessary to an equipment of the highest grade and to enable the company to maintain a safe and reliable high-speed service has been omitted. Great credit is due to the management of this company, which consists of P. S. Arkwright, president; T. K. Glenn, vice-president; G. W. Brine, secretary and treasurer; and A. Balsley, chief engineer, for the successful entrance of alternating current into the southern railway field and for their pioneer work in this important development of electric transportation. The work of installation and construction has been done almost entirely by the company itself, including the track and overhead construction which was conducted under the management of William Glenn, engineer of maintenance of way.

Directed Wireless Telegraphy.

Early in July some experiments were conducted at Strasburg by Dr. Ferdinand Braun with a system of directed wireless telegraphy which he has invented. The results seem to him very promising, for he was able at will to direct the waves so as to actuate the receiver at the receiving station or not. Dr. Braun in several German journals discusses his experiments, and points out the probable usefulness of his developments.

Since electric waves are governed by the same laws as light waves, it should be possible to throw a beam in one direction by means of a parabolic reflector, but the practical difficulties in the way seem to be insuperable. It occurred to Dr. Braun, however, that he could construct a system of sending wires which could be made to intensify the wave in one direction and interfere with it in other directions. If two sending wires are tuned to exactly the same pitch and are operated by the same exciting apparatus, but are so arranged that one of them will be set in vibration a small fraction of a second later than the other, it should be possible to obtain interference. The difficulties encountered in doing this are those of tuning two oscillators to the same pitch, and of producing the desired difference in phase. New methods had to be devised for measuring these exceedingly small time differences. This has been done, but the method is not described. Extended laboratory experiments resulted in the development of means of tuning the wires and for producing the difference in phase sought without throwing the two wires out of tune. In this work Dr. Braun was assisted by Dr. Papalexi, of the Strasburg Institute, and Dr. Mandelstam, who cooperated with him.



SENDING STATION, BRAUN WIRELESS TELEGRAPH EXPERIMENTS.

The laboratory results agreeing satisfactorily with the theory, it remained to test the system on a practical scale. Fortunately a suitable place for carrying out this work on a larger scale was available

in the large drill ground at Strasburg, known as the Polygon, which was courteously tendered to the experimenters by the military authorities. The investigations were carried out on a small scale as compared with wireless telegraph transmission systems, since it was desirable to obtain quantitative, and not merely qualitative, results. It was intended to measure the difference in intensity of the waves sent out in different directions, and for this purpose a relatively short transmission was advantageous.

The sending station consisted of three wooden masts arranged at the corners of an equilateral triangle. Upon each of these masts was stretched a wire or antenna, from the lower point of which a connecting wire was carried to a wooden building placed at the centre of the triangle, in which are mounted the various sending devices. A sketch of the arrangement is given in the accompanying figure. By means of the apparatus contained in the building it was possible to set the wires on posts 1 and 2 into synchronous vibration, and to set up a vibration of the wire on post 3 of the same pitch, but which lagged or led in phase the vibrations of the other two. Assuming the vibration of wire 3 to be slightly lagging, interference between it and that of wires 1 and 2 would take place in the direction from 3 over the house at right angles to the plane containing posts 1 and 2. This amounts to throwing an electrical shadow in that direction. If, on the other hand, the vibrations of wire 3 were made to lead those of 1 and 2 by a proper amount, an amplified wave would be sent out in the same direction, and a shadow thrown backward from wire 3, and at the same time, interference on the sides would take place. In carrying out this work it was necessary to obtain great accuracy in timing the vibrations of the three wires. The time difference was about one-ten-millionth part of a second. Dr. Braun concludes from his work that it is possible to adjust the time difference to within a two-hundred-millionth part of a second. This amounts to an accuracy of one second in six years.

This system of three masts is only a particularly simple arrangement, for more sending wires might be used with an augmented effect; but for the work in hand the simplicity of the system presented some important advantages. It should be noted that transmission is not limited to one direction only with three masts, for it can be sent in the reverse direction by reversing the phase relations. By alternating the function of wire 3 with that of wires 1 and 2 it is possible to transmit messages at will in six directions. The simple addition of a commutating switch in the sending station enables this change in direction to be made easily and at will. It was found that the receiving apparatus at a particular position responded without fail when this commutating switch was in one position, and yet showed no signs when the position of the switch was changed. The distance of the sending station was in these researches 1.3 kilometres.

The results of the experiments were completely in accord with the laboratory investigation and with theory. In other words, it is possible by means of this arrangement to direct a wireless message through a fairly narrow angle. Dispersion takes place and is not small, but there is a decided electrical shadow in the reverse direction, and there is, in fact, a wide angle in which no effect can be measured.

If the receiving station had been equipped for transmitting messages also, it would have had three or more antennæ, and there is no doubt that these wires could be used in an analogous way for increasing the effect at that point.

The use of more than three wires would enable the transmission to be sent out through a still smaller angle, with a less degree of dispersion; but it would complicate the system somewhat. The system as it is, with the three wires, is considerably more complicated than that having but a single wire, and the question is raised whether a parabolic reflector consisting of a number of wires properly arranged might not be employed with but a single oscillating wire at the focus. This is shown to be impracticable, since to be of any value with waves of the length of 120 metres, which is comparatively short, and therefore relatively favorable for this purpose—the sending wire should be about thirty metres from the reflector, and the latter should have an opening of about 120 metres at the focus. Moreover, this reflector should be extended many hundred metres at the sides in order to prevent dispersion. A reflecting wire placed at this distance from the sending wire occupies a very small angle, and hence would be almost useless as a reflector. It was found that the three wires, as used in the interference system, had no effect whatever as a reflector. Although there is no fundamental reason why this difficulty should not be overcome, there is the other objection that the parabolic reflector should be about a kilometre long to give results comparable with those obtained with the three-wire system described.

The Strasburg tests, in Dr. Braun's opinion, demonstrate that a directed system of wireless telegraphy is practicable. Five wires might be substituted, which would increase the action in one direction and give rise to less dispersion, but the three-wire system gives results as favorable as could be expected.

Harvard-Tech Merger Suit.

The Massachusetts Supreme Court handed down, on September 6, a decision in which it rules that the Massachusetts Institute of Technology can not use more than one-third of its estate in the city of Boston for buildings, and can not sell the property under the grant given by the legislature of 1861.

Indirectly, the construction of the grant made to the corporation has an important bearing on the Harvard-Technology merger plan, in view of the contemplated purpose of the corporation to sell its property when the consummation of that scheme would render its further use unnecessary. Under the terms of the grant to the Institute of Technology and the Natural History Society, the square now occupied by both was to be reserved forever as an open space or for the use of the two societies; but neither society was to cover more than one-third of its area with buildings.

Madison Square Garden Electrical Show.

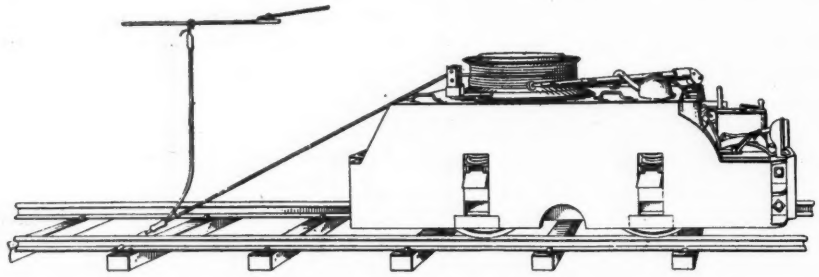
The Madison Square Garden Electrical Show will be held at Madison Square Garden, New York city, from December 11 to 23, inclusive. The director of exhibits is Dr. George F. Sever, of the department of electricity, Columbia University. It is announced that enough exhibitors have been secured to make the show an attractive one. A list of the exhibitors will be published shortly. The office of the exhibition company is at 26 Cortlandt street, New York city.

Fire at Niagara Power-House.

On the evening of Saturday, September 9, a short-circuit occurred in the cables of the Pittsburg Reduction Company running from the power-house of the Niagara Falls Hydraulic and Manufacturing Company at the water's edge in the gorge at Niagara Falls to the aluminum works at the top of the high bank. It is understood that considerable damage was caused to a number of cables. The forebay gate and forebay structure in the rear of the aluminum works were damaged. The fire was extinguished after working about an hour and a half.

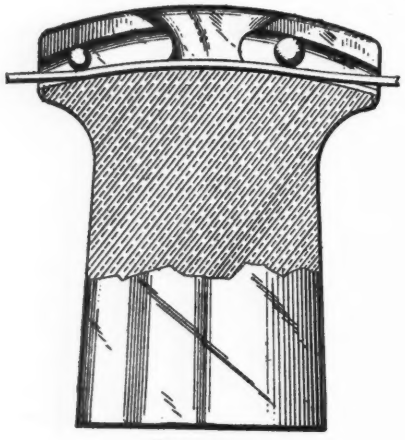
Electrical Patents.

Nils D. Levin, of Chicago, Ill., has assigned to the Goodman Manufacturing Company, of Chicago, Ill., a patent recently granted to him on an electric car or locomotive (797,589, August 22, 1905). The invention relates to electric cars or locomotives that are adapted to operate upon a railway track or upon a road-bed of any desired construction—as, for instance, a pavement—and it relates especially to means for supplying the motor or motors of the car with electrical energy. An electric motor is provided and also a plurality of means, mounted on the car, for supplying current to the motor. A spring-pressed trolley acts as one of such means in combination with an electric switch and a flexible cable constitutes the other means in combination with a mechanically active connection between the trolley and the switch, and an electrical connection between the switch and the cable.



Electric Car or Locomotive.

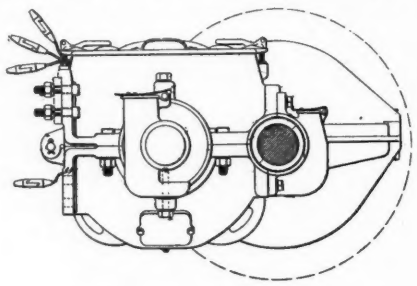
William R. Twiggs, Sandusky, Ohio, is the inventor of an insulator, on which he has recently obtained a United States patent (798,235, August 29, 1905).



Insulator.

The object of the invention is to improve the construction of such devices by rendering them capable of holding the line-wire securely without the use of the tie-wires or similar fastening devices. The invention resides in an insulator formed with a central depression from which lead off in opposite directions a plurality of downwardly inclined slots which taper toward their outer ends and are adapted to receive the line-wire, the wire being held in the slots by balls inserted through the central depression and engaging the line-wire.

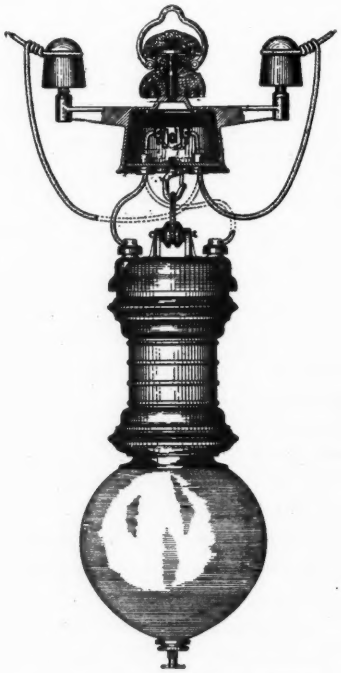
The Westinghouse Electric and Manufacturing Company, Pittsburg, Pa., controls the entire interest in a patent recently granted to Henry R. Edgecomb, Edgewood Park, Pa., on a gear-casing for



Gear Casing for Electric Railway Motors

electric railway motors (798,173, August 29, 1905). The object of the invention is to provide a casing of the above character, the two halves of which are removable from the gears independently of each other. It has been proposed to so construct railway motors that either half of the field-magnet frame may be opened or removed without disturbing the other half, this feature being of considerable advantage in the operation of electric railways which are equipped with both single and double-truck cars, since the same motors may then be employed on both types of cars. In connection with such motors it is desirable, if not necessary, to employ casings for the gears between the armature shafts and the driving axles that are divided into two parts which are removable independently of each other. The present invention provides a gearing-case which meets these conditions and comprises a driving axle and an electric motor having a field-magnet frame divided, in a plane through the axes of the armature shaft and the driving axle, into two parts that are provided with lugs by means of which the armature may be supported from either part. Axle caps are secured to both parts of the field-magnet frame, one of which is provided with a bracket. A gear-case is formed in two parts which are secured independently of each other respectively to the upper half of the field-magnet frame and the upper side of the bracket and to the lower half of the field-magnet frame and the lower side of the bracket.

An arc-lamp hanger and cutout has been patented by Charles E. Harthan, of Lynn, Mass., and assigned by him to the General Electric Company, of Schenectady, N. Y. (797,806, August 22, 1905). The object of the invention is to provide an improved arc-lamp hanger and cutout for use on high-tension circuits in which the operative parts are effectually protected from the weather and from injury by rough usage. In carrying out the invention a bell-shaped enclosing shell is provided, this shell being open at its lower end and having an electric switch secured therein. The switch is provided with means for a transmitting motion to the shell. A removable plate is secured to the shell over its open end and is provided with means for actuating from the

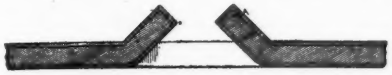


Arc Lamp Hanger and Cutout.

outside the motion-transmitting means carried by the switch.

Thomas A. Edison, of Orange, N. J., has recently devised and patented an improved sheet-metal for perforated pockets of storage batteries (797,845, August 22,

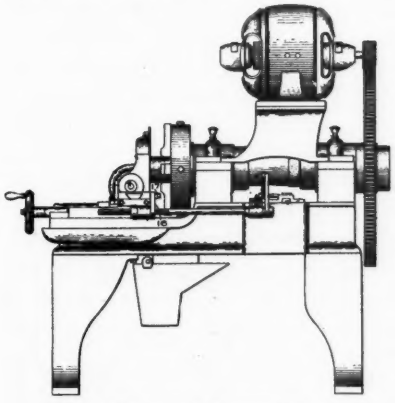
1905). In the manufacture of his improved iron-nickel storage battery, Mr. Edison carries the active material in small pockets made of perforated nickel-plated sheet-steel, the bulk of active material in each pocket being so selected that any change in the mass thereof in use will fall within the elastic limits



SHEET METAL FOR PERFORATED POCKETS OF STORAGE BATTERIES.

of the sheet-metal, whereby the walls of the pockets will always maintain an elastic contact with the active material. It is found in practice that in order that the sheet-metal may be stiff enough to exert a sufficient elastic pressure on the active mass it should not be less than 0.0035 of an inch in thickness, but in commercially experimenting with sheet-metal of this thickness it is found that it can not be practically perforated with the desired fineness, since the dies become quickly worn out. The present invention consists in making the pockets for use in the improved storage battery or in any other storage battery of metal thin enough to be readily perforated, say, 0.025 of an inch in thickness, and in then applying thereto a very thick plating of nickel to a sufficient extent as to result in the production of a sheet of the proper thickness to give the desired elastic pressure; the thickness of the deposited metal varying, as, for example, between 0.0005 and 0.00125 of an inch.

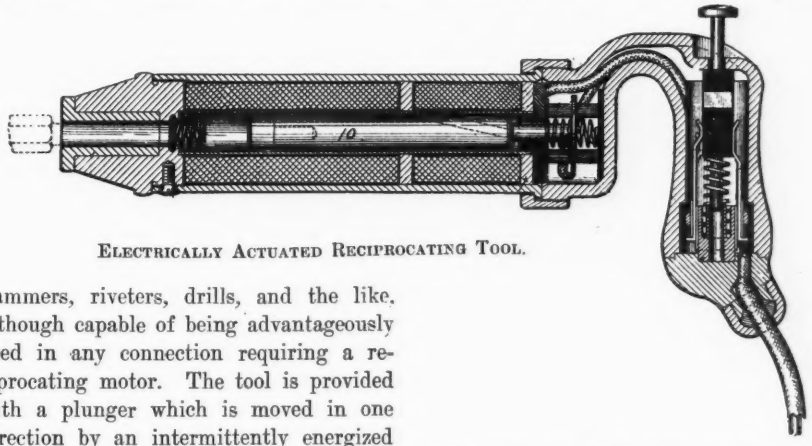
A motor-driven machine tool is the invention of Harold H. Clark, of Lynn, Mass., and the patent obtained thereon



MOTOR-DRIVEN MACHINE TOOL

has been assigned to the General Electric Company, Schenectady, N. Y. (798,391, August 29, 1905). The invention has for its object to so regulate and apply the electric current that a single motor of ordinary construction will operate to drive a machine tool at a substantially uniform cutting speed and with a torque proportional to the cutting radius. The invention comprises a compound-wound motor suitably supported and connected to the spindle of a machine tool and rheostat of peculiar construction connected in circuit therewith and having its operating arm connected to some part, as the tool carriage, whereby the position of the arm is determined by the position of the cutting tool.

Alonzo W. McArthur, Lynn, Mass., and John G. Crawford, Chicago, Ill., are the joint inventors of an electrically actuated reciprocating tool (798,290, August 29, 1905). The invention is more particularly applicable to percussion tools, such as



ELECTRICALLY ACTUATED RECIPROCATING TOOL.

hammers, riveters, drills, and the like, although capable of being advantageously used in any connection requiring a reciprocating motor. The tool is provided with a plunger which is moved in one direction by an intermittently energized coil. A separate continuously energized coil moves the plunger in the opposite direction, and means are provided for intermittently completing the circuit of the first coil through the plunger during determined fractions of the plunger movement.

Fusion of Glass by Electricity.

A very complete study has been given by M. Bronn of the various electrical furnaces which have been designed for the production of glass. Most of these are of the arc type, and have certain disadvantages. The loss of heat from radiation is great, and where carbon electrodes are employed, carbon dust is thrown off by the electrodes and mingles with the glass. The amount of this dust increases with the increase in the length of the arc. Attempts have been made to overcome this disadvantage by adding oxidizing materials to the raw material, but they do not seem to have been altogether satisfactory. Tests have been made with metallic electrodes in place of the carbon, but electrodes of brass melted when in service and iron electrodes became magnetized and were drawn into contact. In some systems the arc is produced above the glass, and is deflected against the material by means of an electromagnet. This system has some advantages, but the pointed form of the arc heats the glass to a high temperature locally, and sometimes burns through the side of the containing-vessel. Experiments made with furnaces of the arc type show that from four to six kilowatt-hours are required to produce a kilogramme of molten glass. The glass obtained contained considerably more silicon than the ordinary mixtures, so that this electric furnace will be useful if glasses of this type are desired; but for ordinary purposes it is too expensive. Another type of furnace having some advantages over the arc is that in which the heating material is powdered carbon or kryptol. In furnaces of this type the material to be fused is placed in a containing-vessel which is then surrounded by the resistance material. This enables an excellent heat insulation to be obtained, and thus reduces very greatly the loss due to radiation. When putting in the resistance material it is necessary to see that it is not compacted, and that the grains are of uniform size and evenly distributed around the crucible. The arrangement of the furnace may be such as to produce a higher temperature at one part than at another. One difficulty in using a furnace of this type is the high current density employed, but a suitable regulating rheostat has been devised which consists of an insulated cylinder filled with the powdered material. A block of carbon at the bottom forms one electrode, and the second electrode is a rod of carbon or some other material which is forced down into the loose material. The conducting mass may be distributed around the crucible in various ways. In some of them triangular sticks of carbon are placed in contact with the crucible in order to concentrate the current there. By means of this arrangement the glass may be fused at low temperatures compared with the temperature of the arc. The furnaces may be regulated to give any temperature up to 1,600 to 1,700 degrees centigrade, with a precision of ten to fifteen per cent. The voltage used in the experiments was about 100.—*Bulletin de la Societé d'Encouragement (Paris), July.*

Reviews of Current Engineering and Scientific Literature.

Chemical and Industrial Applications of Brush Discharges.

A summary is here given by Dr. Alfred Nodon of the various uses made of the brush discharge of electricity. That application which has attracted the most notice is the production of ozone, particularly for sterilizing water—its most important use. A great number of ozonizers have been invented in an endeavor to obtain an efficient type. Unfortunately, none of these gives a very high efficiency. Theoretically, one French horse-power-hour (736 watt-hours) should produce 1,030 grammes of ozone. Assuming a mechanical efficiency of forty per cent, one should then obtain 412 grammes of ozone per horse-power-hour. In practice the production of ozone with the best ozonizers does not surpass 409 grammes per electrical horse-power-hour; with ordinary ozonizers it is only 209 grammes. With systems already established an efficiency of fifteen per cent has been obtained. If the ozonizers are cooled it should be possible to obtain efficiencies of from thirty to forty per cent. Under these conditions the net price of ozone should be about twenty-five cents per kilogramme—a price which is too high for it to be used in general industries. If the price could be lowered to from four to six cents per kilogramme, ozone would be widely used and industrially. By means of Siemens & Halske ozonizers eighty cubic metres of ozonized air will purify forty-two cubic metres of water per hour, taking the cost of purifying a cubic metre of water about 0.15 cent. With the Tyndal ozonizer, operating at 50,000 volts, the price of sterilizing a cubic metre of water is said to be 0.014 cent. Other useful applications of ozone are the production of sulphuric acid, the formation of iodoform, and of a number of flavorings and perfumes. The author also refers briefly to the use of the brush discharge in the fixation of nitrogen. A number of nitrates may be formed in this way.—*Translated and abstracted from L'Électricien (Paris), August 26.*

The Use of Electric Traction for the Transportation of Mail.

A society was formed some time ago in France to investigate the possibility of using high-speed electric traction for the transportation of mail matter. The means available for carrying out the work was not large, so that the most economical construction was adopted. A circular track with a radius of 500 metres was built last year, and equipped with a high-speed car. The system was ready for testing in October, 1904, but the investigation was suspended during the winter on account of the bad weather. As it was desired to reach speeds of not less than 250 kilometres per hour, corresponding to seventy metres per second, a type of structure was necessary which would prevent overturning of the car at curves. The most suitable system seemed to be a circular structure having a single running rail at the bottom, and a guide rail at the top. This construction permitted the turning of the two rails on curves so as to preserve the equilibrium of the car. At speeds of 250 kilometres per hour, and on a radius of 500 metres, it was found that this tilting of the track would be about forty-five degrees. If a curve of shorter radius should be necessary it would be advisable to reduce the speed of the car. The structure adopted for the experiment was a series of square frames strongly braced at the angles, and set up in a triangular-shaped ditch. The running rail was attached to one of the inclined sides of the frame, while the guide rail was fastened to the opposite side. The working conductors were mounted on insulators attached to a third side of the structure. The car consists of a long iron body having parabolic ends, and carried on two grooved running wheels. The guiding wheels consist of two pairs of conical rollers pivoted so as to revolve in a horizontal direction on the roof of the car, and held against the running rail by springs. The motive power is two three-phase induction motors. These are of the four-pole type and are supplied with current at 1,000 volts, forty cycles. Each motor is belted to its corresponding running wheel by means of two leather belts, and the proper belt tension is maintained by a spring. The car is divided into five sections. The two extreme sections contain the electrically operated oiling system. There is here a small direct-current motor driving a three-throw oil pump, power being supplied from a small accumulator. These sections also contain the braking appliances, when such are thought to be necessary, though it is believed that since the friction of the air forms the greatest part of the resistance to motion at these high speeds that it can be utilized for stopping the train. The next two compartments contain the motors and the running wheels, while the central compartment, which is a little less than two metres long, is used for the material to be transported. The car is 7.6 metres in length over all. The distance between the centres of the running wheels is 4.9 metres. The height of the body is about one metre, while the width is ninety centimetres. The useful load is 500 kilogrammes. It is thought that if experience shows that the air resistance is not sufficiently great to stop the car within a short section, wings can be added which will be closed when the car is in motion and thrown out automatically when it is to be stopped. It was found that five minutes were required to bring the car to full speed from standstill, and the same length of time is required to bring it to rest from full speed. Current is collected by means of two sets of three bows each, which are pressed against the working conductors. No figures regarding the power required, nor the speed attained in the experiments are mentioned. —*Translated and abstracted from L'Industrie Électrique (Paris), August 25.*

Superheated Steam.

In this section of the serial entitled "Modern Power-Plant Design and Economics," Mr. Franz Koester takes up the various parts of the boiler-house equipment. Under the section devoted to superheated steam an estimate of the benefits of this apparatus is given. Assuming that an engine running with dry superheated steam consumes fourteen pounds per horse-power-hour, a saving of fifteen per cent may be made by superheating the steam 135 degrees Fahrenheit. This reduces the steam consumption to 11.9 pounds. Assuming an evaporation of eight pounds of water per pound of coal, the coal per horse-power-hour is reduced from 1.75 to 1.48 in order to produce the required amount of saturated steam. Ten per cent must be added to the latter figure to allow for superheating, which raises the coal consumption to 1.62 pounds. Applying these figures to a 500-kilowatt unit running twenty-four hours a day, 360 days in the year, it is found that by the use of superheated steam the water consumption will be reduced by 1,944,000 cubic feet, which at $1 per thousand cubic feet would bring an annual saving of $1,944. For the same unit the annual coal consumption will be 50,652 tons. The use of the superheater will effect a saving of 7.4 per

cent, or 3,748 tons, which at $2.50 per ton would amount to $9,370. This gives a total saving of $11,314 per year due to the use of superheated steam, and a plant containing ten such units would show an annual saving of $113,140. Assuming sixty boilers to be necessary for the operation of this plant, and one superheater to cost $2,000, it will be seen that the total additional cost of $120,000 would be almost repaid in the first year. A superheater may be advantageous in another way: for example, in a certain European power plant containing five boilers, the demands for steam made it necessary either to install an additional boiler or to put in superheaters. As the space available was limited, the latter course was adopted, with the result that four boilers supplied the demand for steam, leaving the fifth as a reserve. The introduction of superheated steam is taking place at a slower rate in this country than in Europe, for there 300 degrees is frequently employed. No trouble is experienced in operating the engines, since a proper proportion between the areas of heating surfaces is maintained.—*Abstracted from the Engineering Magazine (New York), September.*

Notes on Mains Work and Fault Finding.

In the introduction to these notes on mains work and fault finding, the author, Mr. C. G. Knight, makes some interesting suggestions regarding the laying of electric conductors underground. Upon laying any cable, whether it be a feeder, a distributor or service wire, its situation and gauge are ordinarily marked on the maps, but this record is thought to be incomplete if it does not contain the insulation resistance between the conductors and the earth and a description of the cable itself. This should contain the length, the gauge or cross-section, a complete description of the type of cable, and the computed resistance. All these data should be kept on the record sheets on which the regular test reports are made. An additional convenience in caring for underground conductors is to have a set of plans of the distributing system made on squared paper, showing the main cable as if straightened out, and the service wires in the same condition at right angles to it. This enables the distance between various points of the system, measured along the conductors, to be determined quickly, and is a great help in locating a fault. When laying a distributing main which is fed from one end only, it is never advisable to bury the far end so as to make it inaccessible. Frequently it is convenient, if not necessary, to test faults from both ends, and if it is not thought advisable to put down a junction box at the far end, proper terminals should be attached and the whole end enclosed in a blank end-box filled with bitumen and paraffine. It is preferable that this end-box should be enclosed in a brick chamber.—*Abstracted from the Electrical Review (London), August 25.*

Artificial Diamonds.

Of the two phases of carbon, diamond and graphite, diamond is the denser, and also has the less internal energy. It follows that if carbon can be crystallized at comparatively low temperatures, the minimum pressure sufficing to determine the diamond form will be lower than that employed in Moissan's experiments. Following out this idea, Mr. C. V. Burton describes here some experimental attempts to obtain artificial diamonds. From obtainable data it is deduced that the temperature corresponding to atmospheric pressure at which diamonds would be formed lies somewhere between 550 and 700 degrees centigrade, or not far without these limits. Molten alloy of lead, containing about one per cent of calcium, appears to be capable of holding in solution some small proportion of carbon which exists either as free carbon or as calcium carbide, and if the calcium be eliminated from the molten mass, some carbon crystallizes out. Steam may be used to convert the calcium into the hydrate without attacking the lead. If the reaction takes place at a full red heat, graphite is found in the crust of lime. If, however, only a very low red heat has been attained, no graphite is found, but a number of small microscopic crystals, which apparently have the properties of the diamond. The crystals obtained exhibit faces of the octahedron modified by the dodecahedron. They are perfectly transparent and without flaws. The refractive index, as accurately as could be determined on account of the small size of the crystals and the convexity of their faces, appears to be 2.43. The crystals are unacted upon by ordinary acids, hot or cold, by cold hydrofluoric acid, and by fused alkali at a red heat. When strongly heated on platinum foil they burn away, leaving no residue. The quantities which have been obtained to the present time are too small for the ready determination of density or hardness. Negative results were obtained on the commercial calcium carbide which was used in preparing the alloys. Tin may be used in place of lead, but has the disadvantage of oxidizing when exposed to the steam.—*Abstracted from Nature (London), August 24.*

Measurement of the Slip of Induction Motors.

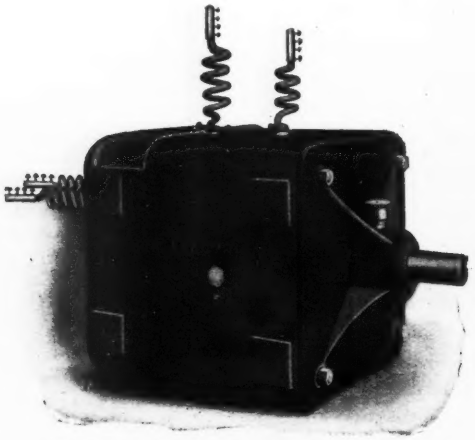
The various methods which have been devised for measuring the slip of induction motors are here reviewed by Dr. C. B. Drysdale, and then a new arrangement is described, which has the great advantage of being direct reading. This instrument consists of a conical cylinder of boxwood or other suitable material, which is connected directly to the shaft of the motor whose slip is to be determined. It is thus driven at the same speed as the motor. Upon this conical roller rests a light disc pivoted so as to have but little friction. This disc is painted in sectors alternately black and white to correspond to the number of poles of the motor. It is held in a carriage, which enables it to be shifted along the conical roller so as to run upon the latter at any point. The sector is lighted by means of an arc or incandescent lamp supplied from the circuit operating the motor. The disc should have a diameter equal to the central diameter of the conical roller. To use the instrument, the disc carriage is shifted along until the figure on the disc apparently stands still. When this position is reached the pointer on the carriage indicates the percentage slip. If the diameters of the small and large ends of the roller be d_1 and d_2, respectively, and the diameter of the disc be D; the length of the roller l; N and n the synchronous and motor speeds, respectively, and x the distance of the disc from the position corresponding to no slip, then the percentage slip is equal to $100\left(\frac{N-n}{N}\right)$, and $x = \frac{D\,l}{d_2 - d_1}\,\frac{s}{100 - s}$, from which x can be calculated for various positive and negative values of the slip, and the scale divided off. To set the zero of the scale accurately, and check the calibration if desired, the simplest plan is to attach a second disc to the end of the roller shaft, with radial slits in it. If, then, the roller be rotated by a motor at any speed, and the roller disc be observed through the slits, or by means of a lamp behind the slotted disc, the figure on the roller disc is seen, and the zero of the scale is set to the position where the figure remains stationary. This simple device is very convenient for use in testing motors, since it is not only direct reading, enabling the slip to be determined instantly, but it is accurate and sensitive. It will frequently indicate changes in load which the testing brake will not show, and since it is accurate it offers a convenient method for determining the speed of the motor as well as the slip.—*Abstracted from the Electrician (London), August 25.*

INDUSTRIAL SECTION.

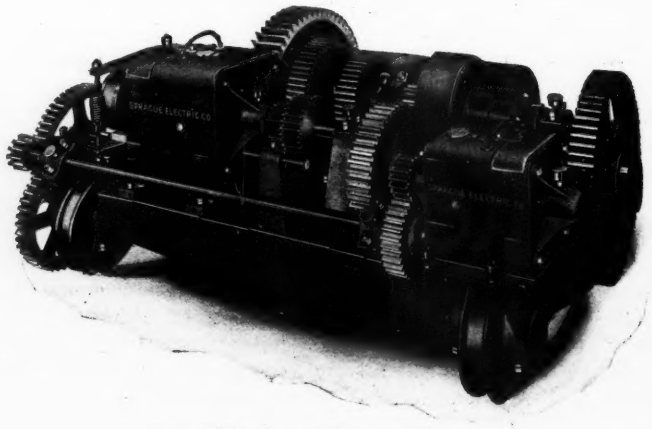
ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Motors for Crane Service.

The Sprague Electric Company, 527 West Thirty-fourth street, New York city, has placed on the market a line of direct-current motors especially designed for crane service. These are designated as type N motors, and the company guarantees that each piece of material used in the construction is the best obtainable, and that all work is done by skilled mechanics, making the completed motor unusually efficient and exceedingly strong. The accompanying illustrations give a good idea of the general appearance of the motors. The particular strains which must be met in crane operation have been kept in mind in designing and constructing these machines. Every line in the design and every element of material has been given consideration with respect to its relations to crane work. The motor frame is made exceptionally strong and well proportioned. The motor shaft is stronger and larger in diameter than motors of a like rating built for ordinary power service. The bearings are large, strongly built, easily renewed, and easily inspected, and they are thoroughly protected against grit and dirt. No brush-shifting device is needed, the motor being designed and built so that when once adjusted for its regular work no shifting of the brushes will be necessary under any conditions of load, when operating in either direction of rotation.



ENTIRELY ENCLOSED AND DUST-PROOF.

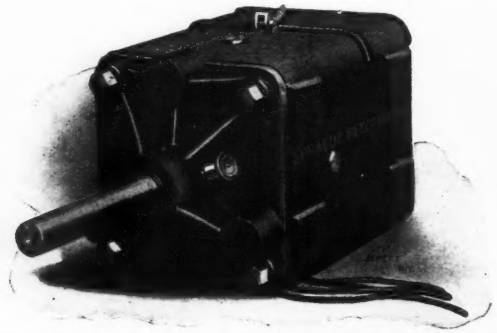


TYPE "N" CRANE MOTORS IN POSITION.

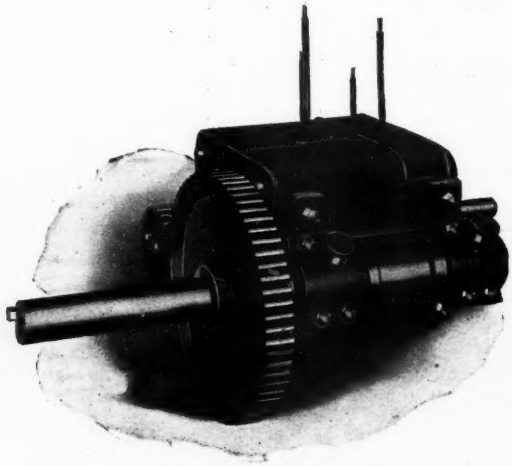
A series winding has been adopted. This gives comparatively high speed on light loads, as, for instance, when the hook is lifted light. The armature windings of these crane motors interlock, and are further held in position by heavy special band wires placed both on the core and on the ends of the coils.

It is necessary that the speed of the crane motor be much slower when a heavy load is being lifted than when a light load is moved. The crane motor must take care of the regulation automatically and up to quite wide limits.

The field frames are made of a special mixture of soft electrical steel in one solid piece. The fields are rectangular in form, without joints of any kind. The frame design includes a set of four bosses on each side and the bottom of the motor. Any one of these sets can be drilled and tapped for the support of the motor. If back gears are used the bosses are drilled and tapped for the support of back gear bearings.



SPECIAL END-SHIELD, DESIGNED FOR TELPHER SERVICE.



SHOWING THE BACK-GEARING.

The ends of the motor field are formed by two bearing shields which support the armature and render the motor field dust-proof.

For inspection of the commutator and brush rigging, a convenient opening is made in the field frame over the entire commutator. When the motor is in opera-

tion this opening is closed with a suitable cover fitted to render the motor dustproof.

The field-coils are form-wound, of insulated copper wire. The coils are assembled on the pole-pieces on the workmen's benches, and after being assembled on the pole-pieces, the completed field magnets are installed in the frame and locked into place.

The armatures are of iron-clad construction, built up of insulated steel laminations. The component parts of the armature core are compressed in place upon the shaft and securely keyed and locked.

Form-wound armature coils, shaped in special forms, are used. In addition to the interlocking feature of the coils, the armature is wound around at several points, both on the core and on the coils where they project from the core, with band wires. In addition to the insulating cell enveloping each armature coil, the slots of the core are insulated with mica and insulating board before the coils are placed in position. After the armature has been completed, a breakdown test of 2,000 volts alternating current is applied to the various coils and commutator bars.

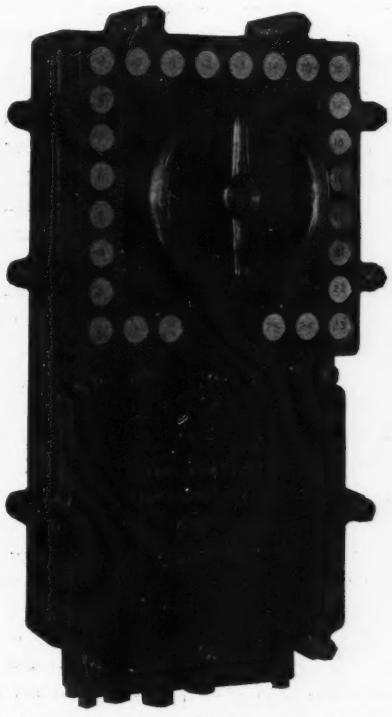
The commutators are built from forged pure copper, selected for uniformity of density and satisfactory grain. Inspected mica is used for the insulation of the segments, the sheets being carefully selected and gauged according to thickness as well as perfection. After the commutator segments with the mica insulation are assembled, they are securely clamped on the commutator spider and subsequently pressed and keyed into position on the shaft.

The brush-holders are designed to take account of the frequent reversals of direction of operation necessary with crane motor operation. The brush-holders are made so that they can be adjusted for the wear of the commutator, the tension being practically uniform throughout the life of the brush. The carbon may be fed to the commutator until almost wholly used. The rocker arm supporting the brush-holders is a strong iron ring, from which the brush-holders are thoroughly insulated by heavy mica insulation. The brush-holders are bolted securely to the rocker arm, and the entire rigging is securely mounted on the commutator bonnet to prevent vibration and consequent sparking. The rocker arm is so mounted on the end shield that when the end shield is taken off the brush-holders complete, with leads, are removed with it, leaving the armature and commutator perfectly clear for removal or inspection.

The bearings are furnished for either grease or oil lubrication. They are held in the end shields in such a manner that, while easily removed, they are securely retained in place.

The Closing of Bulkhead Doors by Electricity.

On many of the new warships of the United States navy there has been installed what is known as the "long-arm" system of electrically operated bulkhead doors and hatches. The heart of this system is the central emergency station, from which the doors and hatch plates may be closed by starting the motors with which they are equipped. The working parts of the station are contained in a two-part water-tight case secured to the side of the pilot house or other convenient place above decks. The apparatus of the station consists of three parts: the mechanism for controlling the circuits running to each door or hatch gear for closing; the lamps which indicate the closing of each door or hatch; the fuse box in which each entering wire is supplied with its proper fuse.



CENTRAL EMERGENCY STATION FOR CLOSING BULKHEAD DOORS FROM A DISTANCE.

The accompanying illustration shows two views of the emergency station—one with the protective covering removed, and the other closed for regular service.

In operating the emergency station the officer in charge releases a hand wheel, which, in turn, releases a gear driven by a powerful spring, and controlled by suitable escapement. This gearing closes the circuits for operating the emergency switches located in the controller of the door and hatch gear. The gearing of the various doors and hatches is started one after the other at about a three-second interval. It rarely happens that more than four motors are in operation at one time. However, the entire closure of twenty-four doors and hatch gears controlled from one emergency station may be accomplished normally in about a minute and a quarter. When an extremely quick closing of all doors is required, this time can be reduced to thirty seconds for twenty-four doors by simply using the hand on the wheel of the emergency station to hurry it.

As each bulkhead door reaches its water-tight seat, it automatically closes a circuit running to the emergency station, and connected with a small incandescent lamp. Transparent discs over these lamps bear numbers corresponding to the numbers of the various doors under control. The officer in charge, by pressing a button, can cause the indicator lamp of each closed door and hatch to glow, ensuring the successful operation of the emergency action. If any door is prevented from closing by obstructions left in its path, this fact is at once apparent to the officer in charge.

CENTRAL EMERGENCY STATION, COVERS REMOVED.

This apparatus is made by the "Long-Arm" System Company, Cleveland, Ohio.

New National Code Fuse Plug.

An all-porcelain Edison fuse plug has been designed by the Peru Electric Manufacturing Company, Peru, Ind. This plug embodies entirely new features and is so constructed that no spark or molten metal is thrown from the plug when the fuse blows. On account of this special factor of safety, and the fact that the fuse has a gravity action ensuring the circuit to open at the proper time, this device is National Code standard.

Fig. 1 shows the neat appearance of this

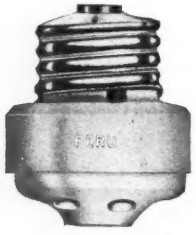


FIG. 1.—NEW FUSE PLUG.

plug. It will be noted that there are openings in the cover which indicate when the fuse is blown. The rating of the plug in volts and amperes is placed in the centre of the cover, making it plainly visible when the plug is installed. A feature of special merit is found in the plastic material holding the base and cover securely together, and which, in addition, serves as a cushion, reducing breakage to a minimum even when the plug is dropped or thrown on the floor.

Fig. 2 shows the inside construction of

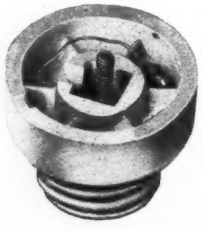


FIG. 2.—NEW FUSE PLUG.

the plug. This device takes an extra long fuse, which assures perfect action. The fuse lies across knife-edge projections in the porcelain, allowing gravity to pull on the fuse in the molten state, opening the circuit exactly in accordance with the new code rating. The fuse wire is soldered to a square lug, which is held in a deep countersink by the centre screw. The other end of the fuse wire is soldered to a terminal connecting with the contact shell.

Allis-Chalmers Company's Report.

Owing to the change in the termination of the fiscal year of the Allis-Chalmers Company from April 30 to June 30, no exact comparison may be made between the annual report just published and the preceding report. The two periods may be compared as follows:

	1905. 14 Months.	1904. 12 Months.	Changes Dec.
Net profits....	$68,982	$952,624	$883,642
Divs. pfd. stock (5¼%).....	.....	853,125	853,125
Surplus.....	$68,982	$99,499	$30,517

The consolidated profit and loss account for the fourteen months ended June 30 last, including the results of the Bullock Electric Manufacturing Company for the sixteen months ending that date, shows a surplus of $348,289.

Since the close of the fiscal year ended April 30, 1904, expenditures have been made for additions to plants amounting to a total of $303,685. Deducting real estate sold, the total capital expenditures in the last fiscal period remains at $289,685. There has been expended in the last year $752,860 for maintenance and repairs and $325,139 for depreciation, a total of $1,077,999, which amount has been included as part of the operating expenses. The report says: "the contraction in general business referred to in the last annual report, as then justifying the postponement of dividends, continued during the first half of the last fiscal period, with particular manifestation in the steam engine department of this company. This was due largely to the introduction of steam turbines, especially those of large capacity, for which certain manufacturers had been preparing for several years. The present manufacturing space and facilities being inadequate for the manufacture of the new lines of machinery referred to, and in order to provide for the economical manufacture of electrical apparatus in the same works where the prime movers are constructed, it was decided to make important additions to the West Allis works, and new buildings are now in process of erection pursuant to the original plans therefor. The capacity of this plant will be nearly doubled by these enlargements. Our engineers have been engaged during the past year in improving our established standard lines of apparatus and machinery, and in reducing its cost. Steam turbine, hydraulic turbine and gas engine departments have been established, and a full corps of competent engineers, having special training in these particular lines, have been engaged. To the already well established line of mining and crushing machinery manufactured by your company has been added a line of steam and hydraulic dredges and steam shovels, for heavy excavating and mining work.

"Soon after the commencement of this calendar year an improvement was manifested in the general business of the company, the orders increasing in April to the normal volume and since then exceeding in extent the previous record of the organization; but the result of these orders will be realized only upon their execution and the delivery of the work. This increase pertained more particularly to the older branches of the business of the company. The steam turbine rights heretofore acquired by this company have been supplemented in an important manner by further patent acquisition and alliances, so that it is confidently asserted that this company is now prepared to place upon the market steam turbine and turbo-generating units that will enable it to retain its position as a leading manufacturer of steam engines of the most successful types. The works are now engaged in filling one of the largest single orders for steam turbines that has ever been placed in this country, the installation of which will be completed by the end of the present calendar year. A number of important contracts for hydraulic turbines have also been secured."

A Floating Exposition.

The Export Shipping Company, 9-11 Broadway, New York city, proposes to equip a large steamer and furnish space thereon to American manufacturers to make a display of their products and send them around the world on a 60,000-mile trip, to consume about fifteen months.

The plan is to allow each person who subscribes for forty square feet of space or more to display his goods and to send on the steamer a representative whose duty it will be to see that the exhibit is properly arranged at each port to meet the merchants and dealers invited to inspect the exhibits; explain the utility and advantages of the goods; quote prices for delivery in the country of consumption; appoint agents, and extend the sale of the goods. The date of arrival in the ports will be advertised, and all interested will be advised to obtain tickets of admission at the newspaper offices, the chamber of commerce, the American consulate, or at the office of the Export Shipping Company. It is also proposed to print in the language of each country a catalogue showing the name of each exhibitor, the name of his representative, the position of the display in the ship, and a full description of the goods exhibited.

The expense of the trip is to be borne entirely by sale of space on a mutual basis. The available space is 20,000 square feet, and the price is fixed at fifty dollars per square foot.

The Olympic Club Clambake.

A genuine old-fashioned Rhode Island clambake was given by the Olympic Club at Bay Shore, L. I., last Saturday afternoon. Many of the members of this historic old club are electrical men and they turned out in numbers on this occasion, and enjoyed one of the best bakes ever given by the organization.

President James Kempster was master of ceremonies, and was ably assisted by Cyrus O. Baker, James Wenman, Henry L. Shippy, Samuel Greene and Geo. Millar. In the evening a reception was given at the beautiful home of the president, adjoining the extensive grounds of the club.

So that our electrical friends may know just what a real clambake should consist of, the menu is published, a copy being kindly supplied by Mr. Baker:

Hard and Soft Clams.
Sheepshead, with White Potatoes.
John L. Wilson, Song—
"The Way to Discover the North Pole."
Honeycombed Tripe and Onions.
Sugar Corn on the Cob.
Wm. Redmond, Song—
"We'll Drown It in the Bowl."
Scallops, with Sweet Potatoes.
Chicken Lobsters.
Wm. Redmond and John L. Wilson, Duet—
"The Moon Has Raised Her Lamps."
Long Island Chickens, with Sweet Potatoes.
Watermelon.
Boston Brown and White Bread.
"Stalker's Celebrated Sauce."
Ruinart Brüt, White Seal, Mumm Extra Dry, Budweiser.
Frank C. Shaffer, Harry Schulte, Banjoists; Henry Frantzen, Accompanist.
Entertainment Will Be Continued During Evening in Sun-Parlor.
E. G. Cormack, Steward.

Electric Light Plant in India.

An electric light plant is to be erected in Mussoorie, British India. Offers are invited for the following materials: steel pipes, water turbines, alternating dynamos, switchboards and instruments, transformers, induction motors, pumps, tools and implements for the workshops. The foregoing are to be supplied and erected by the contracting party, but the following simply supplied: plain copper conducting wires, insulators, arc and incandescent lamps, telephone plants, tools, sundry materials. The conditions may be obtained from the city engineer, C. H. Chanan, Municipal Office, Mussoorie, upon deposit of seventy-five rupees (about twenty-five dollars), which sum will be returned upon presentation of bona fide offers. Sealed offers in the prescribed form, bearing the heading "Tender for electric lighting and waterworks scheme," are to be in the hands of the "Chairman, Municipal Board, Mussoorie, U. P., India," by October 23, 1905.

The Selection of Electric Power Arrangements for Shops.

From a paper presented to the New England Railroad Club by Mr. T. W. Adams, general foreman Readville shops, New York, New Haven & Hartford Railway, is taken the following account of the reasons underlying the selection of electric power arrangements characteristic of that plant:

After determining on the use of the electric drive and having also decided it advisable to deliver the power to the shops in the form of alternating current, it then became a matter for very careful consideration as to whether alternating or direct-current motors and lights were best suited to the particular local requirements, and in view of the isolation of the different machines to be operated, as to whether it was advisable to drive each machine with its own individual motor or to group them and so install the motors that one motor would operate a number of machines located in its own immediate vicinity.

The capability of alternating-current induction motors to handle heavy overloads for short periods without any ill effect allowed of the installation of much smaller motors than would have been possible had direct-current motors been used, and this made a very material gain in first cost of the motor equipment. The entire absence of commutators and brushes made the cost of maintenance also much less and, due to the inflammable nature of a great deal of the work, this last feature also made the alternating-current motors highly desirable.

The transfer table required the use of a variable-speed motor and it was found desirable to use a direct-current motor which could be designed to give a much more gradual speed variation than was practical with the alternating-current motors.

The matter of determining as to how far the subdivision of the power should be carried was also an item of very careful consideration and was approached from both extremes, namely, first, the individual connection of each machine to its own independent motor and consequent elimination of all shafting and belting. Second, the delivering of the power from the power station to one or two large motors so located as to deliver the power to the machines through the medium of long lines of shafting and belting was carefully considered.

The first method was found to entail a first cost of more than was commensurate with the advantages obtained, and from the fact that small motors were less efficient than large motors, it then became necessary to determine if this loss in efficiency was as much as would be represented by the shafting and belting required by the second proposed method.

It was found that the cost of the shafting and belting plus the cost of the large motors, while being less than the first cost of the first method, represented an efficiency loss which would represent more than the interest on the difference in the investment, and the two methods were brought nearer together, step by step, until a compromise of both was finally adopted, resulting in a very reasonable first cost and maximum efficiency in operation, which also resulted in a minimum cost of maintenance.

This compromise was to drive individually such machines as would occupy an isolated position and which were used more or less intermittently, and when used consumed power practically at full output of the motor by which it was operated (this plan was followed in blacksmith shop), and operating in common from one motor such machines as could be conveniently grouped without necessity for the use of large or long shafts and belts, and such machines as were operated with varying power, thus being able to use smaller motors than the aggregate maximum requirements of the several machines would indicate as being necessary, from the fact that the case would seldom, if ever, occur when each machine would call for maximum power at the same instant, and, even if they should, it would occur so seldom and for so short a period as to be a matter of very little moment. This also resulted in reducing the first cost and increasing the efficiency of the system as a whole. It was finally decided that the polyphase motors were by far the most feasible and best solution of the question.

Reliability, adaptability and simplicity were potent factors in their favor, and combined with the facts that they could be used on a long-distance transmission and were free from sparking and moving contacts clearly proved the superiority of the polyphase system for this installation. —*Railway Age.*

Owing to an error in the advance copies of the papers read before the meeting of the International Association of Municipal Electricians, in two references appearing in the ELECTRICAL REVIEW concerning the municipal plant at Detroit, credit was given for authorship to Louis Gascoigne, of Detroit, Mich. The author of the paper was A. S. Hatch, Detroit, Mich.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

AMERICANS TO BUILD LARGE POWER PLANT IN CANADA—Plans are under way for the development of a considerable amount of power at Grand Falls, New Brunswick, by a company prepared to spend between $3,000,000 and $4,000,000. It is proposed to manufacture ferromanganese, pulp and paper, to erect sawmills and operate electric railroads, and to transmit power to St. John, to be utilized for lighting and manufacturing purposes. It is understood that several American capitalists are interested in the enterprise.

LARGE POWER PLANT AT MILFORD, OHIO—The Cincinnati, Milford & Loveland Traction Company has closed contracts with Cincinnati parties for a $1,000,000 power-house at Milford, Ohio. This power-house will operate the entire system from Cincinnati to Blanchester, Ohio, and will be modern in every detail. The work on the twenty-one-mile extension from Milford to Blanchester is progressing rapidly. The work of construction is under the charge of Mr. C. J. Kiefer, chief engineer. The Columbia Iron Works has the contract for the structural steel for the power-house building; the Bullock Electric Manufacturing Company for all the electrical machinery; and the Allis-Chalmers Company for the engines.

AN EXTENSIVE TRACTION SALE—The Elkins-Widener traction syndicate is extending its investments through Ohio and Indiana at a rapid rate. For some weeks negotiations have been going on for three of the important lines in the two states owned by the Tucker-Anthony syndicate, of Boston. It is reported that the negotiations have reached a critical point, and that a consummation may take place at any time. The lines included are as follows: the Columbus, Buckeye Lake & Newark, with a capital stock of $1,000,000 common and $500,000 preferred, operating a road forty miles long from Columbus to Newark and Buckeye Lake; the Columbus, Newark & Zanesville, with forty-four miles of track, and a capital of $850,000 common and $400,000 preferred, operating a line from Newark to Zanesville and Granville; the Indianapolis & Northwestern, with eighty-eight miles of track, and a capital stock of $2,500,000 common and $450,000 preferred, operating a line from Indianapolis to Lafayette and Crawfordsville. This makes a total mileage of 172 miles, with $5,450,000 stock issue and $4,960,000 bond issue.

TROLLEY LINE MAY EXTEND FOR 200 MILES—Judge Alexander D. McConnell has approved the report of the board of viewers, recommending the erection of a joint county bridge across the Monongahela river between Donora and Webster, Pa. The Washington County court has already taken favorable action. The cost of the bridge will be shared by both counties. With the building of this bridge between Donora and Webster, Monessen, Pa., will have another outlet to Pittsburg by way of the extensive trolley loops contemplated by the Pittsburg Railways Company and the Pittsburg, McKeesport & Connellsville Street Railways Company. The Pittsburg Railways Company is now working on its survey of the extension of the Pittsburg & Charleroi line to Brownsville, touching Roscoe, Wood Run, Coal Center and California. At West Brownsville it will cross the river, connecting with the great coke region belt of the Pittsburg, McKeesport & Connellsville company's new line from Lecrone to Brownsville. The Pittsburg, McKeesport & Connellsville Street Railways Company is now closing the five-mile gap between Irwin and Trafford City, which, when completed, will give Pittsburg a trolley line eighty-five miles in length, reaching Masontown, Fayette County. The Pittsburg Railways Company will reach Brownsville by ten miles of track. When the loop is completed it will feed from a territory populated by nearly 1,000,000, and the line will be over 200 miles long.

MEXICAN ELECTRICAL NOTES—Negotiations for the sale of the two street car lines of Monterey, Mexico, have been completed. Messrs. MacKenzie, Mann & Company, headed by Mr. William MacKenzie, of Toronto, Canada, has purchased the property and will electrify the two lines as soon as possible. A concession granted some time ago to the firm of Mackin & Dillon, of Monterey, for the construction and operation of an electric street car line, was also purchased by the new company. With this concession and those under which the mule cars are operated, the new company will have complete control of the street car rights in Monterey. The Mexican Power Company, a Philadelphia concern with an authorized capital of $10,000,000, and operating under a New Jersey charter, has been organized and is preparing to utilize the water power of three rivers in the state of Mexico, near Toluca. It is estimated that electrical energy to the amount of 90,000 horse-power is available for transmission to the city of Mexico. A syndicate has been formed to exploit the waterfalls of Micos, a short distance from San Luis Potosi. According to the report of surveyors, not less than 10,000 horse-power can be obtained and conveyed to Tampico and other towns. A company has been organized in Zacatecas, composed of merchants and business men of the town, with a capital of $100,000, to erect an electric light and power plant and to convey the current to the different parts of the city and its suburbs by means of underground cables. The installation of this plant will be begun in the near future. A concession has been secured by M. R. Martinez to utilize the waters of the Atoyac river, in the state of Puebla, for motive power purposes.

ELECTRIC RAILWAYS.

KANSAS CITY, KAN.—Hugh A. Holmes, of New York city, has announced the letting of the contract for the proposed new electric railroad line from Kansas City to Iola, Kan.

KALAMAZOO, MICH.—The officials of the Grand Rapids & Indiana Railway state that the water-power plant projected for Kalamazoo this year will not be built until 1906. The plant was to have been erected at the junction of the road and Portage creek at a cost of $20,000.

PHILADELPHIA, PA.—A permit has been issued to the Philadelphia Rapid Transit Company from the bureau of building inspection for the erection of a power-house at Nos. 812-820 Sansom street. The building will be two stories in height and will measure 104 by 107 feet. It will be of brick and is to cost $20,000.

DUNKIRK, IND.—A. W. Kennedy has closed a deal with the Muncie & Hartford Traction Company, whereby the company becomes owner of the business property on the corner of Main and Railroad streets. This deal has been under consideration for some time, as the traction company desired the location for its depot.

TOLEDO, OHIO—Directors of the Toledo, Port Clinton & Lakeside Electric Company have practically decided to extend the road through to Sandusky. Just what route will be taken has not been decided, but the road may be extended from some point between Port Clinton and Marblehead, across the bay and into Sandusky.

OSKALOOSA, IOWA—Oskaloosa has voted to contribute a five per cent tax on the valuation of the city property toward the construction of an electric interurban road between Oskaloosa and Buxton, twenty miles. Two-thirds of the vote of the city was cast. The amount available from the tax added to the stock subscribed makes almost $220,000 in cash raised for the construction of the road. The work is to begin immediately.

PORT CHESTER, N. Y.—The New York, New Haven & Hartford Railroad Company, which recently purchased the New York & Stamford trolley system, is negotiating for right of way for a trolley extension from Port Chester to White Plains. When completed this line will shorten the time between Port Chester, Rye Beach and the county seat at White Plains nearly an hour. It is proposed to construct a double-track road, which will allow a high-speed schedule.

BURLINGTON, VT.—Work on the extension of the electric road from North Adams, Mass., to Bennington, Vt., has been begun.

The extension will be completed this fall if the plans do not miscarry. The entire line will be completed another year.

WESTFIELD, N. Y.—The Chautauqua Traction Company has been granted a franchise by the village board.

NEW HAVEN, CT.—The Consolidated Railway Company is preparing to expend about $40,000 in improving the Winchester avenue line.

DENVER, COL.—An electric railway between Walcott, Wyo., and Denver, Col., is reported to be projected by the board of trade of Saratoga, Wyo.

DAVIS, I. T.—The city council of Davis has granted a franchise to the Oklahoma City, Lexington & Sulphur Springs Electric Railway Company.

PITTSBURG, PA.—The Pittsburg & Butler Street Railway Company has awarded the contract for building its electric railway between Etna and Butler, Pa. The cost will be about $1,000,000.

TOPEKA, KAN.—The Metropolitan Finance and Contracting Company, a New Jersey corporation having a capital stock of $200,000, has been given the right to do business in Kansas. It will build an electric line from West Port to Olathe.

COLUMBUS, OHIO—The line of the Scioto Valley Traction Company between Columbus and Chillicothe has been completed. The traction company has two divisions, the other terminus being Lancaster, paralleling the Norfolk & Western and Hocking Valley railroads.

NEW YORK, N. Y.—The state railroad commission has granted the Glen Cove Railroad Company permission to construct a trolley road three and one-half miles long, from the steamboat landing at Glen Cove to the railroad depot at that place, thence by private right of way to Sea Cliff.

AUGUSTA, ME.—The articles of association of the Norway & Western Railway Company have been approved by the railroad commissioners. The company will build an electric railroad through the towns of Norway, Waterford, Stoneham and Albany, with a branch at South Waterford.

CANANDAIGUA, N. Y.—Parties representing the Geneva & Cayuga lake trolley line are securing rights of way for a connection of Cayuga Lake Park, on Cayuga lake, with the railroad bridge, at the New York Central station of Cayuga, with the ultimate purpose of crossing the lake to continue the line to Auburn.

NEW YORK, N. Y.—The Long Island Railroad has begun the operation of electric trains between Jamaica and Flatbush avenue, Brooklyn. Twenty electric trains will be run daily each way, for the present, out of a total of fifty-six trains each day. The proportion of electric trains will, however, gradually be increased.

MILAN, IND.—The Indianapolis & Southeastern Traction Company has filed a mortgage for $1,000,000 in Riley County, covering the traction road now in operation between Indianapolis and Shelbyville and the franchise from Shelbyville to Greensburg. It also covers the proposed extension from Greensburg to Batesville.

BALLARD, WASH.—Fred E. Sander has been given a franchise to run a spur of track from the end of the Seattle-Everett interurban railway to connect with the Seattle Electric Company's line running from Ballard to Seattle. The result will be that the interurban will have the use of the car line connecting with Seattle and cars may go direct from the latter city to Everett.

TERRE HAUTE, IND.—Work on the trolley line which the Terre Haute Traction and Light Company is building into Sullivan is progressing rapidly. All the grading has been completed as far as Farmersburg and rails have been laid as far as Youngstown. The officials of the company state they will have cars running as far as Farmersburg by November 1.

SPRINGFIELD, OHIO—John S. Harshman, director and promoter of the Springfield, Washington & Chillicothe Traction Company, announces that the work of extending the line as originally planned will be commenced within thirty days, and that it will be in operation to Washington Court House about the middle of next year. Eastern capital has been interested, and a new company will be organized to take over the property.

MONETT, MO.—The city council has passed an ordinance granting a franchise to C. W. Copeland and others for the purpose of constructing and operating an electric car line over the principal streets of Monett. The line is to be extended to Pierce City, a distance of five miles, and the work is to be completed within twelve months. The franchise was ceded for thirty-three years.

WAPAKONETA, OHIO—Arrangements have been made to finance the Sandusky Southwestern Electric Railway. Percy Dickinson and John R. Lowther, of New York, representing a syndicate of bankers, agree to pay off the debts, raise the receivership and underwrite and subscribe for $2,000,000 worth of bonds to finish the line between Wapakoneta and Kenton, and Lima and Bellefontaine. The road is to be completed by November 1. The capital stock will be increased from $1,000,000 to $2,000,000.

PITTSBURG, PA.—Announcement is made by Frank G. Patterson, president of the Southern Traction Company, that work will be started within a month on the construction of a link of electric railways eighteen miles in length, which will connect the eastern terminus of the Southern with the city of Altoona, making a continuous line between Pittsburg and that city. The construction of the new piece of road will cost $450,000. The line when complete will touch all the important towns between the two cities.

SPRINGFIELD, ILL.—The St. Louis, Vandalia, Terre Haute & Eastern Traction Company has been incorporated by the secretary of state, with a capital stock of $1,000,000. The principal office is in East St. Louis. The road will build from East St. Louis, Ill., to Terre Haute, Ind. The county commissioners have signed a franchise permitting the company the use of the bridge over the Wabash at the foot of Main street and right of way on the National road for an approach to the bridge for fifty years at $102,000, payable in yearly instalments, beginning with $1,000 a year. The promoters are Springfield and Chicago men, who say they will begin building at once.

PITTSBURG, PA.—The Pittsburg Railways Company is working on its survey of the extension of the Pittsburg & Charleroi line to Brownsville, touching Roscoe, Wood Run, Coal Center and California. At West Brownsville it will cross the river connecting with the great coke region belt of the Pittsburg, McKeesport & Connellsville company's new line from Lecrone to Brownsville. The Pittsburg, McKeesport & Connelsville company is now closing the five-mile gap between Irwin and Trafford City, which, when completed, will give Pittsburg a trolley line eighty-five miles in length, reaching Masontown, Fayette County. The Pittsburg Street Railways Company will reach Brownsville by ten miles of track.

INDIANAPOLIS, IND.—According to a report electric railway connection between Indianapolis and Cincinnati is planned by the management of the Cincinnati, Lawrenceburg & Aurora Traction Company. This company, it is said, proposes to construct an extension of its line from Harrison, near Cincinnati, to Batesville, Ind., a distance of about thirty miles, to connect at Batesville with the proposed extension of the Shelbyville division of the Indianapolis & Cincinnati Traction Company's line. A. B. Voorhies, of the Union Savings Bank and Trust Company, of Cincinnati, who is one of the officials of the Lawrenceburg & Aurora company, believes that such a connection would give the shortest and best traction line between Cincinnati and Indianapolis.

BURLINGTON, VT.—The permanent survey of the portion of the Ticonderoga Union Terminal Railroad between Adison Junction, the terminal of the Rutland division of the New York Central Railroad, and the junction with the Delaware & Hudson Railroad to Lake George, has been completed. The contract for the construction of the line will be let soon and it is expected that work will be begun within sixty days. The engineers will shortly begin the surveys for a line to Schroon Lake village, a distance of twenty miles from the line as it now exists, and will then continue through the Schroon valley to Lake Placid. It is also intended to construct a line from Westport *via* Elizabethtown to connect with the mail line from Ticonderoga to Lake Placid. A survey will be made from Schroon Lake along the northern side of the lake to Warrensburg, where connections will be made with the Hudson Valley Railway and the Delaware & Hudson. The line will also be extended so as to connect with Paul Smith's railroad at Lake Clear.

TELEPHONE AND TELEGRAPH.

BELFAST, ME.—The Unity Telephone Company is extending its line to Albion Corner.

FALLBROOK, CAL.—The Sunset Telephone Company will extend its line to Fallbrook.

BALTIMORE, MD.—The Cecil Farmers' Telephone Company is building a line to Calvert.

OTTAWA, ILL.—The Lostant Telephone Company has completed the installation of a new switchboard.

OGDEN, UTAH—The Bell Telephone Company is installing three new circuits between Ogden and Salt Lake.

EASTON, N. Y.—The Easton & South Cambridge Telephone Company is extending its line to Crandell's Corners.

PARK CITY, UTAH—The Utah Independent Telephone Company will at once begin the erection of a modern telephone exchange building.

GLENS FALLS, N. Y.—The Hudson River Telephone Company has begun the extension of its underground system. The work will take about four weeks.

READING, PA.—The Long-Distance Telephone Company has a number of men putting up poles and wire along the line from Lebanon to Pottsville.

CHARLOTTE, N. C.—The Southern Bell Telephone Company has entered into an agreement with the local company whereby connection may be had with Hickory.

JACKSONVILLE, FLA.—The Alachua Telephone Company has in operation a direct line to Gainesville, connecting with C. C. Voyle's independent exchange.

HUDSON, N. Y.—The Columbia Telephone Company, of Hudson, is to extend its lines to Kinderhook. The trustees of that village having granted a franchise.

BALTIMORE, MD.—The Bell Telephone Company is pushing work on a long-distance line through West Virginia, which will connect Cumberland with Cincinnati.

ONTARIO, CAL.—The Sunset Telephone Company has been granted a permit by the town officials to erect new lines. No poles are to be put up in the business section.

BRENHAM, TEX.—A new telephone line from the east end of Washington County, starting at Old Washington, *via* Whitman, Block's gin and on to Brenham, is to be built.

GREAT BARRINGTON, MASS.—The American Telephone and Telegraph Company is securing right of way for a line from Pittsfield through Tyringham and New Marlboro to New York.

SYRACUSE, N. Y.—The Independent Telephone Company has purchased the property at East Washington and South State streets, and will use it as the site for the new exchange and headquarters.

CRETE, ILL.—The Interstate Telephone Company has a force of men at work constructing a line to Beecher, where an exchange office will be established. Lines are to be extended in every direction in eastern Will County.

LAS VEGAS, N. MEX.—The Colorado Telephone Company has begun work on the construction of a line from Las Vegas to Santa Fe. Sixty men are employed and it is expected the work will be finished inside of thirty days.

OGDEN, UTAH—The new lines of the Bell Telephone Company into Ogden canyon have been completed into Eden and Huntsville. There are now seventy-five subscribers in Huntsville, in addition to those through the canyon.

PERTH AMBOY, N. J.—The Perth Amboy city council has granted a franchise for twenty-one years to the Hudson & Middlesex Telephone Company. The company must put its wires underground, except on Division street.

MAGNOLIA, MISS.—The Home Telephone Company is transferring all of its holdings in Pike County to the Cumberland Telephone Company, the lease of the lines for two years, held by the Home company, having expired August 1.

PORTLAND, ORE.—Preparations are being made by the Home Telephone Company for building a three-story brick structure at Burnside and North Park streets. The purchase of the quarter-block was made recently for $30,000.

DOLGEVILLE, N. Y.—The Central New York Bell Telephone Company has accepted a twenty-five-year franchise for the use of Main street for poles and wires, and will at once begin work preparatory to establishing a local exchange.

CHAMBERSBURG, PA.—The United Telephone Company is installing a farmers' line of thirty telephones in the western end of Franklin County, running through Hamilton, St. Thomas and Letterkenny townships. Others will be added later.

TOLEDO, OHIO—The Toledo Home Telephone Company has received twenty cars of conduits for the extension of its conduit system. The consignment embraces 100,000 feet. It is the intention of the company to make a number of extensions this fall.

BRIDGEPORT, MD.—The Farmers and Merchants' Telephone Company of Caroline County, covering thirty-two miles of territory, has completed stringing wires, and the entire system will be in operation shortly. The company is purely a local concern.

BINGHAMTON, N. Y.—Permission for the construction of the York state telephone conduit has been granted by the common council. Work will be begun at once, according to the declared intentions of the company, and will probably be completed before winter.

DENVER, COL.—Notice has been filed with the secretary of state of the dissolution of the Pecos Valley Telegraph Company, the main office of which is at Colorado Springs. H. U. Mudge and E. O. Faulkner are, respectively, president and secretary of the company.

KANKAKEE, ILL.—The town board of Herscher has granted a twenty-five-year franchise to the Independent Telephone Company, of Kankakee. The line will be constructed as soon as possible, running to Union Hill by way of Bonfield, then to Reddick and from there to Herscher.

LARNED, KAN.—The Homestead Telephone Company, comprised of a number of farmers in the south half of Pawnee County, is building a rural system throughout that portion of the county. The company will connect with the Larned Telephone Company's Larned exchange for town and toll service.

COLORADO SPRINGS, COL.—The telephones, switchboard and electric appliances of the El Paso Telephone Company, operating in Colorado City, have been sold under chattel mortgage, held by the Chicago Telephone Supply Company, for $4,648.43. Attorneys Spurgeon and Cassidy, representing the creditors, bid the stock in for $4,250.

NORTHBRIDGE, MASS.—The New England Telephone and Telegraph Company has ordered that the district comprising the villages of Rockdale and Riverdale be placed in the Whitinsville exchange. The subscribers have formerly been connected with the Millbury exchange and were obliged to pay toll to communicate with Whitinsville.

TIFFIN, OHIO—James T. Carbin, the independent telephone promoter of northern Ohio, has sold the Bloomville plant and sixty-five miles of toll lines, extending to Griffin, Bucyrus, Shelby and Republic, to the Farmers' Telephone Company for $15,000. Some time since he sold the Republic exchange, also of Seneca County, to the same company for $6,000.

ANN ARBOR, MICH.—The Cavanaugh Lake Rural Telephone Company has filed articles of incorporation in the county clerk's office. The capital stock is $400, of which $240 is paid in. The directors are John Killmer, Herbert Heney, Leonard Loveland. The other stockholders are John Miller, A. D. Main, Pearl Orbring, Henry Phelps and R. M. Hoppe. All the stockholders are from Grass Lake.

MURPHYSBORO, ILL.—The annual meeting of the Jackson County Telephone Company was held at Elkville recently. A special meeting will be held November 14, for the purpose of taking up the question of moving the main office from Elkville to Murphysboro.

The following officers were chosen: president, C. A. Schwartz, of Elkville; vice-president, R. H. Blacklock, Vergennes; secretary, John D. Hayes, Elkville; treasurer, Samuel Schwartz, Elkville.

FARMINGTON, ME.—The Franklin Farmers' Cooperative Telephone Company has been organized to do business among the farmers in certain portions of Franklin County. It is planned to soon erect a line between Farmington, Farmington Falls and New Sharon, later including Vienna and Temple. The officers are as follows: president, H. H. Rice; treasurer, F. E. Voter; directors, H. W. Gilman, W. W. Small, H. H. Rice, George H. Brown, F. E. Voter.

ROCHESTER, N. Y.—The Rochester Telephone Company, which now controls the Syracuse Telephone Company, has begun the work of remodeling the system at Syracuse. It is proposed to increase the capital stock of the company to $1,000,000, of which nearly $600,000 will be spent in improvements. The new switchboard will cost $175,000. It will have an ultimate capacity of 12,000 telephones, although only about half that number will be required at the outset.

SCHENECTADY, N. Y.—The Home Telephone Company has completed its new lines to Saratoga and Glens Falls, opening up territory heretofore reached by way of Troy. The new copper wire service between Schenectady and Saratoga will give Schenectady merchants direct communication with that town, saving the additional expense incurred in the past by making connections by way of Troy. The Glen Falls service will be distinct from the Saratoga service and will also include Whitehall, Granville and Ticonderoga.

CHESTER, PA.—The Bell Telephone Company's new exchange building on Tome street, which was recently completed, has been equipped with the latest improved switchboard. The system will be operated on the common battery plan and the exchange will be transferred from Prospect Park as soon as the company secures a franchise from the borough to use the streets for the construction of an underground system. The switchboard has eighty connections, which will be ample for some time, in view of the fact that party lines are the rule.

TROY, N. Y.—The Hudson River Telephone Company has filed with the city clerk its acceptance of the ordinance passed by the common council recently, permitting the company to place its wires underground in Troy. A bond of $5,000 was also filed with the city clerk to protect the city from all damages which might arise during the time excavations are being made. The telephone company expects to place a large force of men at work at once, as it is intended to have the operations completed before cold weather arrives.

SALT LAKE, UTAH—The Rocky Mountain Bell Telephone Company is rapidly extending its service in various directions, and is also enlarging its city offices. Wire cables, to cost $14,000, in addition to those already in use, have been ordered to be placed between Twelfth South street and Bingham Junction, and an additional circuit will be put in from Casper, Wyo., to Rural Hill, Idaho, taking the line of the proposed extension of the Chicago & Northwestern. There is also to be a $12,000 outlay at Pocatello, Idaho. Major Hill has resigned as director and secretary, and Robert B. Harkness, of Salt Lake City, has been chosen to fill these positions.

SPRINGFIELD, OHIO—The Springfield-New Carlisle Telephone Company has organized by the election of the following officers: C. D. Juvenal, president; J. C. Williams, vice-president; W. W. Morris, secretary and treasurer. The directors are: Isaac F. Studebaker, W. W. Morris, J. C. Williams, S. A. Muff, J. N. Cory, C. D. Juvenal and J. B. McGrew. The company is composed of a number of citizens of New Carlisle and vicinity and of Springfield, including, in addition to those named, A. C. Frahn, A. M. Snyder, W. S. Vale and Dr. F. P. Stafford. The company contemplates the erection of a thoroughly up-to-date telephone plant in New Carlisle as soon as a franchise can be obtained.

NEW PUBLICATION.

DIRECTORY OF MEMBERSHIP OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—The American Institute of Electrical Engineers has published a directory of membership revised to July 1, 1905. There are included two honorary members, 482 members and 3,110 associates—a total of 3,594. An appendix contains the constitution and by-laws of the Institute.

ELECTRICAL SECURITIES.

For a week prices have been confined to lower levels, due to the withdrawal of public support and the skilful manipulations of the bearing interests in the stock market. Indications, however, are that the period of depression will be of short duration as the market is intrinsically and materially sound. While some industrials and railroads, too, report a shrinkage in earnings, the iron and steel business has been notably good, the Carnegie Company announcing its decision to take no more orders for delivery this year. This condition is typical of that prevailing elsewhere, enough contracts being on hand to keep the mills in steady operation for a year to come.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 9.

New York:	*Closing.*
Brooklyn Rapid Transit	66⅝
Consolidated Gas	183
General Electric	179
Interborough Rapid Transit	215
Kings County Electric	200
Manhattan Elevated	164
Metropolitan Street Railway	126½
New York & New Jersey Telephone	169
Westinghouse Manufacturing Company	180

The guaranteed quarterly dividend of 1¾ per cent on the capital stock of the Manhattan Railway Company will be paid by the Interborough Rapid Transit Company, lessee, on and after Monday, October 2, to stockholders of record at the closing of the transfer books on Friday, September 15, at 3 o'clock P. M. The transfer books will be reopened on Wednesday, September 27, at 10 o'clock A. M.

The income account of the Brooklyn Rapid Transit Company for the year ended June 30 is as follows: gross, $16,333,444; expenses, $9,803,870, leaving net of $6,529,574; other income, $252,136, a total of $6,781,710; charges, taxes and betterments, $5,631,776, leaving a surplus of $1,149,934, which, added to the previous surplus, $1,594,189, makes a total surplus of $2,744,123, as compared with $2,753,041 for 1904.

Boston:	*Closing.*
American Telephone and Telegraph	140½
Edison Electric Illuminating	250
Massachusetts Electric	59
New England Telephone	133½
Western Telephone and Telegraph preferred	97

The earnings of the lines operated by the Massachusetts Electric Companies are at present showing gains in excess of the estimates made earlier in the year. At the present rate the net income for the fiscal year ending with September will exceed considerably $800,000, and show the full 4 per cent for the preferred stock.

Philadelphia:	*Closing.*
Electric Company of America	11⅛
Electric Storage Battery common	86
Electric Storage Battery preferred	86
Philadelphia Electric	8 3/16
Philadelphia Rapid Transit	28
United Gas Improvement	98

The Philadelphia Traction Company (leased by the Philadelphia Rapid Transit Company) has declared a semi-annual dividend of $2, payable October 2. Books closed September 9.

Philadelphia Rapid Transit gross earnings for August increased $50,000. This makes an increase for the first two months of the 1905-1906 fiscal year of $130,000, July having run $80,000 ahead.

Chicago:	*Closing.*
Chicago Telephone	136
Chicago Edison Light	155
Metropolitan Elevated preferred	67
National Carbon common	60
National Carbon preferred	115
Union Traction common	7
Union Traction preferred	33

The Chicago Telephone Company reports a gain of 1,498 telephones for August, making the total now in service 133,359.

NEW INCORPORATIONS.

TOPEKA, KAN.—New Hope Telephone Company. $5,000.

DES MOINES, IOWA—Sherman Telephone Company. $2,000.

TOPEKA, KAN.—Marvin & Kirwin Telephone Company. $1,000.

LANSING, MICH.—Cadillac Water and Light Company. $10,000.

FRANKFORT, KY.—Danville Home Telephone Company. $5,000.

MURRAYSVILLE, PA.—Murraysville Telephone Company. $5,000.

MORRISON, ILL.—Morrison Electric Lighting Company. Increased from $20,000 to $60,000.

PLATTSBURGH, N. Y.—Clinton Telephone Company. Increased from $50,000 to $100,000.

ALBION, ILL.—Edwards County Mutual Telephone Company. Increased from $4,048 to $25,000.

MONTGOMERY, ALA.—Home Telephone Company, of Mobile. Increased from $40,000 to $350,000.

ST. LOUIS, MO.—The St. Louis, Vandalia, Terre Haute & Eastern Traction Company. $1,000,000.

BUFFALO, N. Y.—Great Lakes Telegraph Company, Buffalo. $2,500. Directors: J. W. Gerlach, J. C. Dunlop, J. L. Gleen, Buffalo.

LOWELL, MASS.—The Lowell & Fitchburg Electric Company. $400,000. Directors: Thomas H. Hathaway and Charles N. Goodrich.

CHICAGO, ILL.—Austin Electric Light Plant. $10,000. Incorporators: Charles R. Whitman, George E. Dauson and J. Homer Sullivan.

BISMARCK, N. D.—Piatt Electric Company, Cooperstown. $20,000. Incorporators: Chester C. Piatt, Charles C. Piatt, E. H. Ackerman, Cooperstown.

JERSEY CITY, N. J.—United States Independent Telephone Company. To construct and operate telephone and telegraph lines. $100,000. Incorporators: Henry A. Bingham, Richard F. Tully and Robert S. Carmubael.

RICHMOND, VA.—Virginia Light and Power Company, of Ashland. $25,000. Incorporators: H. W. Anderson, president; T. S. Wheelwright, vice-president; G. B. Williams, secretary and treasurer, all of Richmond.

SIOUX FALLS, S. D.—Queen City Electric Light and Power Company. $300,000. Incorporators: H. J. Hanford, of Chicago; Pitt Curtis, of Norwalk, Ohio, and A. Huntington, W. G. Mack and U. S. G. Cherry, of Sioux Falls.

BANGOR, ME.—The Carbonite Gas Company. To manufacture and supply gas and electricity for fuel, heat, light and motive power. $100,000. Officers: J. L. Brophy, of Portland, president; James J. Herman, of Portland, treasurer.

AUGUSTA, ME.—The Bethel-Newry Telephone and Telegraph Company. To construct and operate telephone and telegraph lines in the towns of Bethel and Newry, in Oxford County, Maine. $5,000. Officers: president, T. H. Jewett, of Bethel; treasurer, W. N. Powers, of Newry.

TACOMA, WASH.—Puyallup Valley Railway Company. To build railways, telegraph and telephone lines and electric plants. $250,000. Trustees: Fred J. Chamberlain, W. D. Cotter, W. H. Elvins, J. E. Stevenson, John Millis, W. R. Scott, L. A. Chamberlain and Charles Fulmer, of Puyallup.

WHEELING, W. VA.—Postal Telegraph-Cable Company, of West Virginia. $5,000, of which $2,500 has been subscribed. Incorporators: John O. Stevens, of Plainfield, N. J.; George H. Usher, of New York; Edgar C. Bradley, of Orange, N. J.; Edward C. Cochrane, of New York, and Edward C. Platt, of Brooklyn.

ALBANY, N. Y.—The Genessee River Railroad Company, of New York. To build and operate a steam or electric road thirty-four miles long, from Portage, Livingston County, to Cuba, Allegany County. $350,000. Directors: Frederick D. Underhill, George F. Brownell, Francis L. Stetson, Granville A. Richardson, Charles Steele, Joseph M. Graham, M. P. Blauvelt and J. C. Stuart, of New York, and Herbert A. Taylor, of Upper Montclair, N. J.

ALBANY, N. Y.—Elmira, Corning & Waverly Railway, of Elmira. To construct an electric road thirty-seven miles long. $2,500,000. Directors: Senator William J. Tully, of Corning; G. Tracy Rogers, of Binghamton; A. N. Brodhead and Arthur C. Wade, of Jamestown; Joseph A. Powers and James H. Caldwell, of Troy; Thomas O'Connor, of Waterford; Frederick E. Hawkes and William L. Watrous, of Waverly; George McCann and A. Lee Smith, of Elmira.

WASHINGTON, D. C.—The Washington & Virginia Transit Company. To construct and operate an electric railway from the Virginia end of the new highway bridge to Aldie, in Loudoun County, with branch lines to Falls Church, Fairfax Court House, Centerville, and through the latter town to the Bull Run battlefield. $100,000. Officers: M. E. Church, president; W. C. Pennwitt, vice-president; M. C. Mitchell, second vice-president; John B. Henderson, Jr., secretary, and Charles A. Kolb, treasurer.

INDIANAPOLIS, IND.—Louisville, New Albany, West Baden & French Lick Railway Company. To build an interurban line between New Albany and French Lick, passing through Floyd, Harrison, Washington and Orange counties. $10,000. Directors: L. C. Davis, John F. Finley, George B. Dewess, B. H. Cravens, S. H. Braxton, Thomas Taggart, Lee W. Sinclair, O. S. Kline, W. A. Milton, John Sharp, John H. Leathers, Henry Ormsley, Henry Terstegge, Evan B. Stotsenburg and Marvin W. Ripy.

ELECTRIC LIGHTING.

MILTON, FLA.—Milton is to be lighted electrically by means of current transmitted from Bagdad.

WINTHROP, ME.—The electric light plant of the Winthrop & Wayne Light and Power Company has been placed in operation.

WESTFIELD, WIS.—The vote to establish an electric light plant in Westfield was carried by a majority of fifty.

DEXTER, N. Y.—The Dexter Electric Light and Power Company is building a power-house on the Hounsfield side of the river.

SODUS, N. Y.—The Sodus Gas and Electric Light Company has completed its plant and placed it in operation.

WAUSEON, OHIO—H. H. Williams & Company, the owners of the local electric light plant, are making a number of improvements, including the installation of a new switchboard.

MARYSVILLE, OHIO—The Richwood electric light plant has been sold by Edward A. Schambs, of Richwood, and Colonel C. W. Fisher to a company of Richwood citizens for $20,000.

NORTH VERNON, IND.—Contracts have been awarded by the North Vernon council for new equipment for the municipal electric light plant.

PRINCETON, MINN.—Right of way is being secured by an improvement company for an electric line to carry power from Taylor's Falls to Minneapolis.

ALLENTOWN, PA.—D. W. Kline, of Kutztown, has been awarded the contract to erect the electric light building for that borough. Work will now be hastened.

DEADWOOD, S. D.—Phillips & Bartlett, of Deadwood, have been awarded the contract for the new power-house of the Consolidated Power and Light Company, of South Dakota, at Pluma.

WHITE PLAINS, N. Y.—The Lawrence Park Light and Improvement Company has applied for a franchise in Eastchester. The company's main office will be in Bronxville.

SILVER CITY, N. MEX.—The company which was recently granted a lighting franchise by the city council will be known as the Consumers' Light Company. Material for the plant is being secured.

AUGUSTA, ME.—The Pepperell Company, at Biddeford, is to install an electric light plant to light both the Pepperell and Laconia

divisions by electricity, instead of by gas, as at present. The plant will be installed this fall.

CENTRAL CITY, KY.—Central City is now lighted electrically by the Central City Light and Power Company, of which T. Q. Fortney is president, U. C. Fortney, vice-president, and R. B. Culbertson, secretary-treasurer.

CHILLICOTHE, OHIO—William A. Poland, John Tomlinson, C. W. Story, R. G. Tomlinson and John A. Nipgen have sold their interests in the Chillicothe Electric Light and Power Company to G. A. Vaughters, president of the Citizens' Bank.

CORINTH, N. Y.—The Corinth Electric Light Company, owned by Peter Curtis, Jr., has a force of men engaged in the preliminary work for the building of a wing dam on the Hudson river about one hundred and fifty yards below the river bridge.

MAHANOY CITY, PA.—The Mahanoy City Electric Light, Heat and Power Company has discarded its two eighty-horse-power boilers and has installed a new high-pressure 400-horse-power Keeler boiler. A reserve 200-horse-power boiler will also be retained.

OGDEN, UTAH—E. W. Wade is authority for the statement that a power plant, to cost in the neighborhood of $100,000, including all machinery, will be installed on Blackfoot river, seventeen miles from Blackfoot, Ida., and an equal distance from Idaho Falls. The plant will furnish about 1,000 horse-power, as at present projected.

ST. PAUL, MINN.—A new brick addition to its electric plant on Hill street, to cost $35,000, will be built by the St. Paul Gas Light Company. The building will be used for a boiler room, and will be equipped with all the latest devices. This is the first of a number of improvements to be made by the company in the near future.

SOUTH SAN FRANCISCO, CAL.—The California Gas and Electric Corporation is installing a new line between South San Francisco and the Six-Mile House. The line will connect the auxiliary power-house with the Standard Electric Company and thus give the California company two lines upon which to draw in times of emergency.

NEW YORK, N. Y.—Proposals for alterations to power-house at Fort Wood, New York harbor, will be received until 12 M., September 20, 1905, and then opened. Information will be furnished on application. Envelopes containing proposals should be endorsed "Proposals for Alterations to Power-House," and addressed to Quartermaster.

COLUMBUS, OHIO—The Clay City Electrical Company, of Roseville, has been incorporated with a capital stock of $10,000, to operate an electric light and power plant and to manufacture artificial gas. The incorporators are W. B. Randolph, David L. Melick, S. M. Ryland, T. M. Ransbottom, A. S. Sharp, M. Dwight Walker and H. C. Williams.

HUNTINGDON, PA.—The Juniata Electric Company, a new corporation, contemplates spending $750,000 in building a dam across the Juniata, west of Huntingdon, and erecting a large power plant for the purpose of furnishing electric light and water power for all the manufactories of Altoona, Tyrone, Huntingdon and intermediate towns in the Juniata valley.

RUTLAND, VT.—At the annual meeting of the Rutland City Electric Company these directors were elected: S. M. Hamill, A. H. Jackson and H. M. Francis, of Schenectady, N. Y.; F. M. Butler and George S. Haley, of Rutland. Mr. Hamill was elected president, Mr. Jackson vice-president, Mr. Francis treasurer, Mr. Butler secretary, and Mr. Haley general manager.

BAY CITY, MICH.—George Silsby, of Saginaw, of the Rifle River Power Company, which proposes securing electrical energy from water power on the Rifle river, has received word that the board of supervisors of Ogemaw County has granted the company a franchise to construct dams in the Rifle river in Ogemaw County. The franchises in Arenac County have already been granted. The company claims it will develop enough electrical power to supply the entire Saginaw valley as far south as Saginaw.

KNOXVILLE, TENN.—It is unofficially stated that a movement is on foot at Asheville, N. C., to build a power plant on the Little Tennessee river, at what is known as the "Narrows." The "Narrows" is a passage on the proposed extension of the Knoxville & Augusta, about midway between Bushnell, N. C., and Maryville, Tenn. It is said that the Asheville promoters have eastern capitalists back of the project. The intention is to erect a power plant, similar to the one proposed by the Knoxville Power Company.

OGDEN, UTAH—L. B. Spencer, of Ogden, has filed application with the state engineer for water rights on Ogden river, intending to furnish power and light to Ogden. The diverting channel is to be 10,000 feet, and 1,500 horse-power will be developed to operate three sixty-inch wheels, with 450 feet head. The water will be restored to the river after being used. A. J. Poulson, of Richfield, has filed a claim for eighty second feet from Sevier river, with a diverting channel of 24,000 feet and two twenty-inch wheels with seventy feet head, furnishing 450 horse-power.

TROY, N. Y.—The work of laying brick at the uncompleted plant of the Hudson River Electric Power Company, on the flats, has been commenced. The machinery used to supply power for the street railway system was started the morning of July 1, sheltered by a temporary structure. In October a turbo-generator, considerably larger than any so far received, will be placed in position. One of the smaller machines will then be taken out and room made for other machines of the larger size. It is expected that by the close of the year the plant will have doubled its present capacity.

HOLYOKE, MASS.—For the year ending June 30, the municipal electric and gas lighting plants in Holyoke showed a considerable increase in the amount of business done, and an excess of $14,767.02 of income over expenditure. The gross income was $249,123.48, of which $143,114.78 was from the gas-works. There was a gain of over twenty-five per cent in the income from the electric plant. Five per cent was charged off for depreciation in both plants. There are 464 users of electricity in the city, the population by the new enumeration being 49,124.

KNOXVILLE, TENN.—The board of directors of the Knoxville Power Company held its annual meeting recently. Plans for the proposed power plant, to be erected on Little Tennessee river, were discussed. The following officers were elected: president, Charles H. Treat, New York city; vice-president, John T. Wilder, Knoxville; secretary, John F. Barry, New York city; assistant secretary, L. M. Parker, Knoxville. C. H. Treat, J. T. Wilder, George A. Sullivan, John F. Barry, W. J. Oliver, W. Austin, and L. H. Stevens were elected members of the board of directors for the ensuing year. The financing arrangements for the Knoxville Power Company are said to be complete.

BERLIN, N. H.—The Berlin Electric Light Company, which has had an option on the water power privileges at what is termed the Lead Mine bridge, has bought the same of W. K. Aston, of Shelburne. The contract has been let to Ward Brothers, of Berlin, for the construction of a dam across the Androscoggin, which at this point is 350 feet wide, and of a power-house 110 by 50 feet, the total cost being estimated at between seventy-five and a hundred thousand dollars. It is the purpose of the Berlin Electric Light Company to transmit power to Berlin, and it is expected that at least 1,200 horse-power will be available from this new source. The power-house will be of concrete and will be fireproof.

COLUMBUS, OHIO—The city of Columbus, Ohio, has an electric light plant for sale of 300 lamps capacity. This plant was in service up until a few months ago, when the city ceased to operate it on account of starting its new plant of 2,000 lights, which has been building for some time past. The city therefore offers its old plant for sale, which consists of engine, boiler, condenser, lamps and other equipment necessary to make up a complete plant. The board of public service will, on application, furnish a complete list of the machinery for sale. Sealed proposals will be received by the board, at its office in the City Hall building, until 12 o'clock, noon, of September 19, 1905, for the sale and removal from the property of the city of the above-mentioned machinery, in accordance with ordinance No. 22,361, passed council July 3, 1905.

INDUSTRIAL ITEMS.

THE BILLINGS & SPENCER COMPANY, Hartford, Ct., has issued a new price-list of drop-forged machine wrenches. This catalogue contains full data concerning dimensions and prices and is supplemented by a number of illustrations.

THE ELECTRICAL TESTING LABORATORIES, New York city, has reprinted and is distributing a catalogue descriptive of its equipment at Eightieth street and East End avenue. This matter has been compiled by Dr. Clayton H. Sharp.

PATTERSON, GOTTFRIED & HUNTER, LIMITED, 146 Centre street, New York city, is calling attention to the McClelland oil purifier, which it manufactures. A booklet on oil purifying, and the company's new catalogue No. 45, descriptive of power transmission appliances, may be secured upon application.

THE D. VAN NOSTRAND COMPANY, 23 Murray street, New York city, has issued a series of catalogues and advance sheets concerning new publications on electric lighting, electric railways, long-distance electric power transmission, the insulation of electric machines, modern electrical construction and kindred subjects.

CHARLES R. UNDERHILL, 55 Liberty street, New York city, has recently issued a sheet with thirty-five illustrations, showing various types of alternating-current and direct-current electromagnets. A booklet has also been issued by Mr. Underhill containing facts about electromagnets. Mr. Underhill is the author of an extensive work entitled "The Electromagnet," containing 159 pages and many illustrations. The booklet, "Facts about Electromagnets," and the thirty-five illustrations will be sent free to any address.

W. F. LEGGETT, 56 Pine street, New York city, has initiated a departure in the preparation of supply catalogues for dealers in electrical apparatus. Mr. Leggett purposes to furnish up-to-date catalogues at a moment's notice. The plan of operation is to make this distinctly a manufacturers' catalogue, the leading manufacturers having furnished him with plates of their product, thereby saving the supply houses wishing to list their line extra expense for advertising.

THE SPRAGUE ELECTRIC COMPANY, 527 West Thirty-fourth street, New York city, has issued a handsome bulletin, No. 422, the aim of which is to present, in the shortest possible form, the information that flexible metallic conduit and flexible steel-armored conductors manufactured under the Greenfield patents are used successfully in finished buildings and in new structures under construction for almost any class of electric wiring. The volume consists entirely of illustrations wherein this material has been used. Supplementing each illustration is a brief paragraph giving such data as will indicate the location and type of the structure.

J. G. WHITE & COMPANY, New York city, is building a reenforced concrete power-house for the Waltham Gas Light Company, Waltham, Mass. The entire building is to be of reenforced concrete construction, no exposed steel framework being used. Steam will be supplied by four 350-horse-power Sterling boilers, and suspended coal bunkers will occupy the upper half of the boiler room. The bunkers will be served by coal conveyers, and chutes from the bunkers operated by valves from the boiler-room floor will feed the coal to the furnaces. The main engine equipment will consist of two 500-kilowatt Parsons turbines direct-connected to Westinghouse dynamos.

NEW MANUFACTURING COMPANY.

ALBANY, N. Y.—The Auto Telegraph Company, of New York city, with a capital of $10,000, to manufacture patented telegraph instruments, has been incorporated. The directors are Harrison M. Angle and Edward V. Fleming, of Brooklyn, and George S. Jacob, of Ocean Grove, N. J.

PERSONAL MENTION.

MR. E. L. SIMONDS has been made manager of the Stamford, Ct., office of the Southern New England Telephone Company. Mr. Simonds was formerly a solicitor for the company.

MR. FRANK A. POLHEMUS, acting general manager of the New York & Long Island Traction Company, has resigned and will take a similar position with a large syndicate in Cleveland, Ohio. Mr. Polhemus has been on Long Island since May, 1902.

MR. H. F. STRATTON, who has for some time been connected with the principal office of the Electric Controller and Supply Company, Cleveland, Ohio, has accepted the position of New York representative of the company with offices at 136 Liberty street.

MR. W. L. BUSH, the retiring manager of the Pennsylvania Telephone Company, at Reading, Pa., was tendered a reception by the local employés of the company on the evening of Thursday, August 31. Mr. Bush has accepted a position in the auditing department of the company at Harrisburg.

MR. J. J. CARTY, chief engineer New York Telephone Company, returned to his duties on Monday, September 11, after an extended trip to Great Britain and the Continent. Mr. Carty was accompanied by Mrs. Carty and his son, and has come back refreshed and reinvigorated. He arrived on the S. S. Etruria last Saturday.

MR. ARTHUR F. HOWARD, for the past seven years assistant superintendent of the Portsmouth (N. H.) Electric Railway, has been transferred to the position of assistant to the chief electrician of the Boston & Maine Railroad, with headquarters in Boston. Mr. Howard graduated from the Massachusetts Institute of Technology in the electrical course.

MR. W. S. DORAN has been appointed manager of the power department of the Allis-Chalmers Company, Milwaukee, Wis. He will have charge of the company's commercial affairs pertaining to reciprocating steam engines, steam and hydraulic turbines, condensers, gas engines, blowing engines for iron and steel blast-furnace service, and rolling mill engines. His headquarters will be at the general offices of the Allis-Chalmers Company, Milwaukee. Mr. Doran was formerly associated with the British Westinghouse Electric and Manufacturing Company, Limited. He has had a thorough training and a widely varied experience, qualifying him to carry on this important work. Among the large contracts secured by Mr. Doran are the complete installation of the power and lighting plant for the Midland Railway at Heysham Harbor, England; the new Belfast (Ireland) tramways, and several large iron and steel works plants.

MR. W. S. DORAN.

OBITUARY NOTICES.

MR. WILLIAM B. GILL, formerly a district superintendent of the Western Union Telegraph Company, with headquarters in Philadelphia, Pa., died on September 6 at Cheltenham, a suburb of Philadelphia. He was fifty-nine years of age. Mr. Gill entered the employ of the Western Union company as a messenger boy, and eventually became superintendent of the sixth district, which embraces eastern Pennsylvania, southern New Jersey, Delaware and a portion of Maryland and Virginia. He retired in 1902. Mr. Gill was president and general manager of the Philadelphia Local Telegraph Company, a director in several other companies, and at one time a vice-president of the Bell Telephone Company.

MR. EDWIN R. WHITNEY, a well-known electrical engineer and promoter, formerly a resident of Manchester, N. H., died at the Margaret Pillsbury Hospital, in Concord, N. H., on Friday, September 1. He had been ill for some time, and death was not unexpected. For several years Mr. Whitney has been carrying on a fight for a large sum of money—$1,000,000 or more—which he claimed was due him for his share in the development of the Shawinigan Water and Power Company, of Canada. Mr. Whitney was an electrical inventor and at the head of the Whitney Electrical Instrument Company, with a factory at Penacook. He was the inventor and patentee of a voltmeter and a number of other instruments for the measuring of electrical currents.